VOLUME 62 WINTER 1959 NUMBER 4

THE BRYOLOGIST

Quarterly Journal of the American Bryological Society

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THE BRYOLOGIST.—A quarterly journal devoted to the study of North American mosses, hepatics, and lichens, published by the American Bryological Society. **Subscription price, in the United States, $5.00 per year, net; in all other countries, $5.15.**

Back volumes of THE BRYOLOGIST are available from Dr. Lewis E. Anderson, Department of Botany, Duke University, Durham, N. C.; or the Secretary-Treasurer, at the following prices: volumes 1-4, $1.25 each; volumes 5-36, $2.50 each (60 cents per individual number); volume 37, $3.00; volumes 38-45, $3.50 each (85 cents per individual number); volumes 46-49, $4.00 each; volume 50, $8.00; volumes 51-56, $6.00 each ($2.00 per individual number).

PUBLICATION OFFICE: Seeman Printery, Durham, N. C.

Address manuscripts to the Editor:

DR. HOWARD A. CRUM, National Museum of Canada, Ottawa, Ontario, Canada.

Manuscripts should be typewritten, double-spaced, on 8½ by 11 inch sheets. Only first copies (not carbons) should be submitted. Reprints of articles will be supplied at a reasonable price if ordered when corrected galley proof is returned.

Address subscriptions, applications for membership, and advertisements to the Secretary-Treasurer, DR. VIRGINIA S. BRYAN, Department of Botany, Duke University, Durham, N. C.

Address all specimens for identification directly to the Curator concerned.

Entered as second-class matter at the Post Office at Durham, N. C.

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JOURNAL OF

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PTERYGONEURUM ARCTICUM, A NEW SPECIES FROM NORTHERN ALASKA

WILLIAM CAMPBELL STEERE[1]

The genus *Pterygoneurum*, as presently understood, consists of a half-dozen species, all characterized by the presence on the upper side of the mid-rib of the leaves of two to six well-developed wings or lamellae, whence the name. *Pterygoneurum ovatum* (Hedw.) Dix., *P. lamellatum* (Lindb.) Jur., and *P. subsessile* (Brid.) Jur. all occur in Europe, Asia, and North America. *Pterygoneurum chotticum* (Trab.) Broth. from Algeria, *P. medium* (Salm.) Broth. from Afghanistan, and *P. macleanum* (Rehm.) Warnst. from South Africa, may all be unusual forms of the variable *P. ovatum* (Salmon, 1899). Bartram (1943) has shown that *P. roseae* Williams, described from a Peruvian collection (Williams, 1915), was really based on a species of *Crossidium*.

In 1952, Vaněk proposed a new species, *Pterygoneurum smardacanum*, from southern Slovakia, where it grew on saline soil near Slovensky Mede. According to Boros (1953), the original collection, sent to him by Šmarda for examination, consists of a mixture of dwarf forms of *Phascum acaulon* and *Pterygoneurum pusillum*, which provided the sporophyte and gametophyte, respectively, of Vaněk's "new species."

In North America, the three previously known species of *Pterygoneurum* occur characteristically in slightly to strongly arid climates or habitats, on alkaline or saline soils. *Pterygoneurum*

[1] The New York Botanical Garden, Bronx Park, New York 58, N. Y. Grateful acknowledgment is made to generous support of research, both in the field and the laboratory, by grants from the Office of Naval Research, the Arctic Institute of North America, and the National Science Foundation. A continuing grant from the National Science Foundation (G-6390) has made possible the completion of this paper.

subsessile and *P. ovatum* are widespread in the western prairies and plains, from California, Texas, and Arizona northward to North Dakota and Washington in the United States and to Saskatchewan and British Columbia in Canada. *Pterygoneurum lamellatum*, however, seems to be known in North America primarily from Utah and Arizona (Wareham, 1939). The range of *P. ovatum* in Canada has recently been extended to Ontario in the east and to the Yukon Territory in the northwest by Williams (1959), who has also reviewed the total extent of this species in North America. Kucyniak (1958) reported a collection from Quebec.

In Europe and Asia, the species of *Pterygoneurum* are very widely distributed in drier habitats and in warm and arid climates; Gams (1934) has discussed in some detail their distribution and ecological preferences, and has considered them under the category of "steppe mosses." The ecology of *P. ovatum* (as *P. cavifolium*) and of *P. lamellatum* has been studied and reported very fully by Flowers in a series of papers on the bryophytes and vegetation of Utah (1929, 1933, 1934, 1936). He considered that these two species are typical mosses of the alkaline plains in the vicinity of Great Salt Lake, in the greasewood (*Sarcobatus vermiculatus*)-shadscale (*Atriplex confertifolia*) association. Flowers' remarks (1933) on the remarkably high alkalinity and salinity of the soil that mosses must withstand merit quotation here at some length: "Species of *Bryum*, *Pottia*, *Pterygoneurum*, and *Funaria* were all found in soils showing values above pH 8.5." [His Table II lists *Pterygoneurum* (genus only) as a halophytic moss growing in soil with 0.53% of salts, dry weight, and a pH of 8.6.] "The alkali content of the clay and loam of the greasewood-shadscale association amounts to 0.6% to 1%, the average being about 0.8%. This marks the maximum for mosses of this region. The kind of alkali is an important feature. The most drastic salt is sodium carbonate or "black alkali" and in no instance were mosses found growing in areas carrying any appreciable amounts of this salt. Sodium chloride is the typical salt of this region and mosses will tolerate it up to about 0.5%. Calcium sulphate is the least toxic of the alkalis."

The discovery in the arctic tundra of a new species of a small and specialized genus previously known only in warmer climates is, at first thought, more than a bit surprising. However, arctic America is essentially arid, in terms of rainfall, and the ground level may be relatively warm part of each day during the growing season (Steere, 1955). Moreover, because of the slight rainfall

and consequent slow rate of ice accumulation, Pleistocene glaciation in Alaska north of the Brooks Range was not extensive, so that many obviously unglaciated areas may be recognized today. One of the relatively easily accessible and highly interesting unglaciated areas lies in the vicinity of Umiat, on the Colville River (approx. 69° 23′ N. Lat., 152° 10′ W. Long.). Here, well north of the Arctic Circle, occurs a group of species that clearly represent relics either of a pre-Pleistocene era or of a long, warm interglacial period. Examples are *Tetraphis pellucida*, *Tetrodontium brownianum*, *Grimmia plagiopodia*, *Desmatodon obtusifolius*, *Seligeria calcarea*, *Neckera pennata* var. *oligocarpa*, and *Radula complanata*, among other bryophytes not previously known from arctic America and that would be normally expected much farther south, as in the northern United States. The persistence of mosses in unglaciated areas during the Pleistocene is not a new concept (Steere, 1937a, 1937b; Löve & Löve, 1953), of course, but does not seem to have been applied previously to unglaciated areas *north* of the Pleistocene invasions of ice. The existence of the unglaciated areas themselves, however, is well known and a matter of record. They are mapped in a generalized way in our standard reference works that touch upon the geology, geography, physiography, climatology or ecology of Alaska. In my opinion, there is no doubt that *Pterygoneurum arcticum* persisted on the arctic slope of the Brooks Range through at least a major part of the Pleistocene epoch.

Pterygoneurum arcticum sp. nov.[2,3] (*Fig.* 1-18.) Plants growing on fine, calcareous silt, widely scattered as solitary plants or clustered among other mosses, rarely forming pure or extensive cushions, bright yellowish-green, becoming brown with age. Stems simple, branching by annual innovations, extremely short. Upper leaves much larger, very concave, imbricated to form a bulb-like cluster (*fig.* 1, 2), lingulate to obovate (*fig.* 10, 11), up to 2 mm. long, rarely more, lower leaves broadly ovate (*fig.* 5-7), reaching 1.5 mm., all leaves acute to nearly obtuse, abruptly mucronate to awned; costa excurrent as an awn of variable length, occasionally

[2] Solitare vel raro paullo confertum. Caules simplices, brevissimi, per innovationes divisi. Folia superiora multo maiora, valde concava, caespites bulbaceos formantia, e lingulatis ad obovata, inferiora late ovata, cellulis foliorum utrisque superficibus papillosis; lamellae 2, raro 4, latitudine variantes, apicem versus folii latissimae, fastigatae et evanidae basim versus, valde et singulariter papillosae, irregulariter ad marginem liberam crenulatae. Sporophyta solitaria; capsula e ovata ad oblongo-cylindricam, haud sulcata vel striata siccitate et maturitate, peristomio nullo, operculo systylio. Sporae dense punctatae, ceterum glabrae.

[3] The synopsis was very kindly put into Latin by Dr. H. W. Rickett, The New York Botanical Garden.

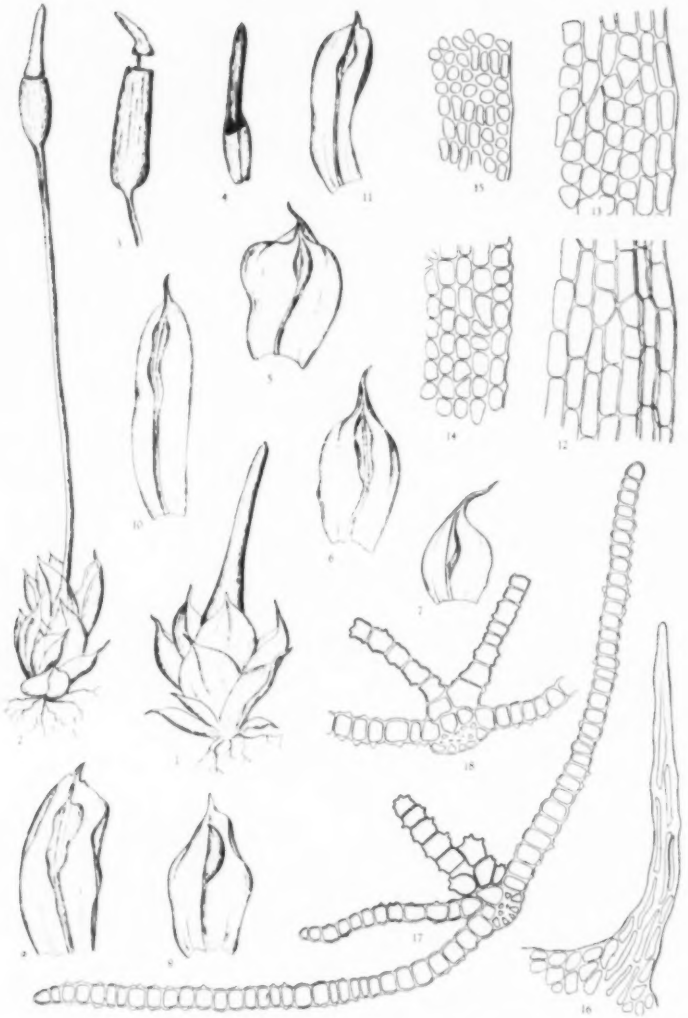

FIG. 1-18. *Pterygoneurum arcticum*. 1. Entire gametophyte with young sporophyte, × 10. 2. Entire gametophyte with mature, operculate sporophyte, × 10. 3. Mature capsule, showing systylious method of dehiscence, × 10. 4. Calyptra with enclosed operculum, × 10. 5-7. Basal leaves, × 21. 8, 9. Leaves from middle of stem, × 21. 10, 11. Uppermost leaves, × 21. 12. Marginal leaf cells at base × 175. 13. Marginal leaf cells just above base, × 175. 14. Marginal leaf cells at widest part of leaf, × 175. 15. Marginal

roughened, in cross-section showing a large dorsal group of stereids and very large ventral thin-walled cells (*fig.* 17, 18), from which the usually 2 (rarely to 4) lamellae appear to rise; lamellae variable in width, even on the same leaf, broadest near the apex, tapering and disappearing toward the base, not producing protonema-like projections, strongly and uniquely papillose (*fig.* 17, 18), irregularly crenulate at the margin, extending at right angles to the lamina or nearly parallel to it; median cells of lamina in rows, rounded quadrate to hexagonal (*fig.* 14), 22 μ in diameter, papillose on both surfaces, apical cells smaller than the median, usually rhomboidal (*fig.* 15), 15 μ, all cells with clear collenchymatous thickenings, basal cells larger, rectangular, somewhat elongated, thinner-walled except at and near margin (*fig.* 12, 13); margin entire or sharply serrate at the apex near the costa; perichaetial leaves longer than the lower leaves and often more conspicuously awned, the innermost reduced in size. Autoicous; antheridia in buds consisting of minute leaves of which the innermost are ecostate, attached below the perichaetium. Sporophytes solitary. Seta rather stout, 4-6 mm. long. Capsule narrowly ovate to oblong-cylindric, rather firm and not sulcate or striate when dry and mature; urn 1.2-1.5 mm. long, glossy reddish brown; peristome lacking; exothecial cells irregularly rectangular, longer than wide, fairly thick-walled; annulus indicated by several rows of smaller, isodiametric, colored, thick-walled cells that do not separate; operculum somewhat oblique, 0.8-1.0 mm. long, rostrate from a convex base, its cell rows slightly but clearly twisted; columella strong, holding the operculum long after the maturity and dehiscence of the capsule in a truly systylious fashion (*fig.* 3). Calyptra cucullate, large (*fig.* 4), reaching nearly to the base of capsule. Spores densely punctate, otherwise appearing smooth, 20-26 μ in diameter, maturing in late summer.

Geographical Distribution in Alaska: On calcareous silt, frost boils on summit of high bluff near Gubic, near confluence of Chandler and Colville rivers, approx. 69° 28′ N. Lat., 151° 30′ W. Long., July 25, 1951, *W.C.S.* 16268; on exposed silt near top of ravine wall, Driftwood Camp area, near headwaters of Utukok River, DeLong Mountains, Brooks Range, approx. 68° 53′ N. Lat., 161° 10′ W. Long., August 10, 1951, *W.C.S.* 16765; on exposed silt, bluffs at southwest corner of Chandler Lake, Endicott Mountains, Brooks Range, approx. 68° 12′ N. Lat., 152° 47′ W. Long., July 22, 1952, *W.C.S.* 18464, 18491, July 23, 1952, *W.C.S.* 18517; on bare silt, on bank cut by stream, south of Schrader Lake, southwest of Mt. Chamberlin,

leaf cells near apex, × 175. 16. Cellular detail of leaf apex, × 175. 17, 18. Cross-section of leaf, showing papillose lamellae and lamina, × 175. (Original drawings made from type collection and plate prepared by Miss Jennifer Wootton.)

Franklin Mountains, Brooks Range, approx. 69° 22′ N. Lat., 145° 03′ W. Long., July 30, 1952, *W.C.S.* 18993, TYPE.

Because of the long-exserted capsule lacking a peristome (*fig. 2, 3*), this moss most closely resembles *P. ovatum*. It differs, however, in the broader leaves, papillose on both surfaces, and in the uniquely papillose lamellae (*fig. 17, 18*), totally without protonematal outgrowths, as well as in the systylious capsule (*fig. 3*), a feature not previously reported for *Pterygoneurum*. It is easily distinguished from *P. lamellatum* by the lack of a peristome (*fig. 3*), and from *P. subsessile* by the exserted capsule and cucullate calyptra (*fig. 4*).

Since traces of a peristome may be found, in the Pottiaceae, below the mouth of the capsule or persistent within the falling operculum, both capsule mouth and operculum were dissected and their inner surfaces searched carefully, but without finding any trace of a peristome except for one anomalous case. At the mouth of one capsule, not quite mature, from which the lid had been dissected with a needle, were seen two ghost-like remnants of some sort of vestigial and ephemeral peristome structure, in the form of two extremely transparent vesicles 40 μ high containing irregular, hyaline, finely papillose fragments in two rows of three each. Although not seen again in other capsules, these suggestive structures are supposed to be remnants of rudimentary thickenings from the potentially peristome-producing tissue, but which never develop further.

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TENIOLA, A NEW GENUS OF MOSSES

WILLIAM D. REESE[1]

In the course of recent work on the genus *Calymperes*, it became evident that one species had no natural affinities with the genus and should be excluded. The unique character of the species precludes its assignment to any existing genus, and so a new genus is described to accommodate it.

Teniola gen. nov. Planta 0.5-2.5 cm. alta, fusco-viridis, crescens singule aut in glaebis paucorum; folia elliptica; apices obtusi; teniolae validae, intramarginales e vicinitate basis folii usque ad apicem; margines plani, unistratosi aut conjunctes teniolas in superiore $^1/_3$ folii; cellulae in medio folio rotundae vel angulatae, ca. 6:5 μ, in superiore $^1/_3$ folii in ventro mammillosae, in dorso laeves aut cum minimis papillis; costa valida, percurrens vel breviter excurrens; propagula multicellulata, ovato-oblongata, usque ad 150 × 360 μ, affixa pediculo tenuissimo in caule inter bases foliorum. Dioica? Fructus ignotus.

Teniola fluviatilis (Williams) n. comb. *Calymperes fluviatile* Williams, Bull. Torrey Bot. Club 47: 394. 1920. Plants dark green, light green toward the tips, up to 2.5 cm. tall, unbranched; leaves involute and more or less contorted when dry, widely

[1] Dept. of Biology, Southwestern Louisiana Institute, Lafayette, La. I am indebted to Mrs. Catherine Cornay for aid with the Latin description.

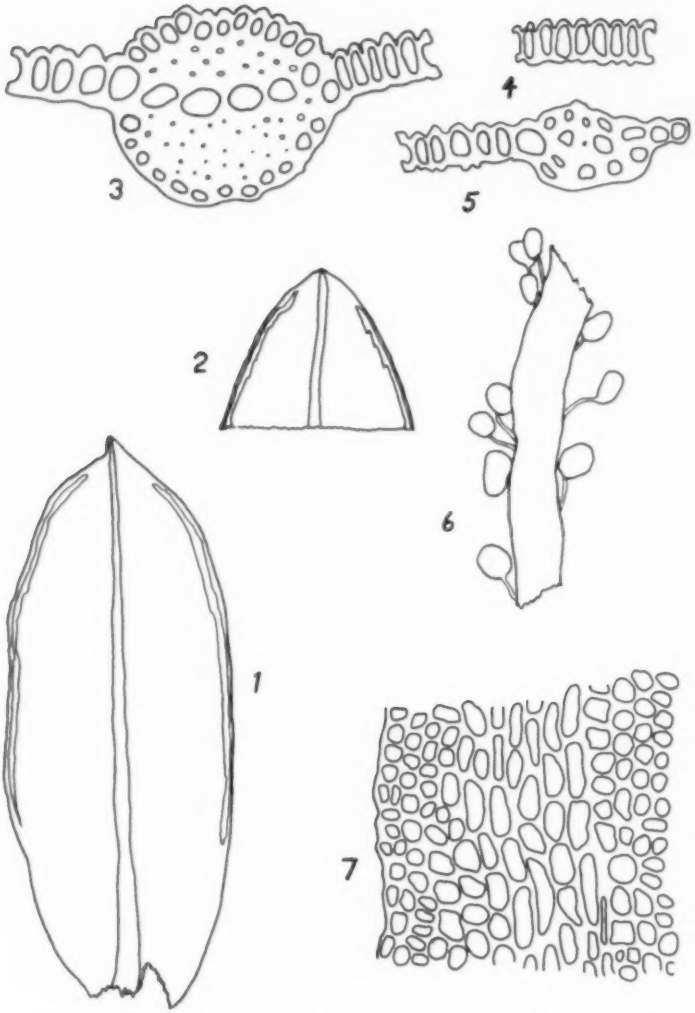

FIG. 1-7. *Teniola fluviatilis*. 1. Leaf, × 23. 2. Leaf tip, × 23. 3. Cross-section of costa, × 380. 4. Cross-section of leaf cells, × 380. 5. Cross-section of leaf margin, × 380. 6. Portion of stem with leaves removed to show the propagula, × 23. 7. Margin and cells at mid-leaf, × 380. (Fig. 1 from *Nash* 666a, Haiti; fig. 2-7 from type.)

spreading and remaining somewhat involute when moist, up to 3.5 mm. long by 1.3 mm. broad, broadly elliptical; apices obtuse; margins entire or minutely serrulate by projecting cell angles and papillae, occasionally irregularly serrate at the apex, plane, unistratose or merging with the teniolae in the upper ⅓ of the leaf; costa strong, percurrent or more often shortly excurrent, smooth on both sides in the lower part of the leaf, papillose ventrally toward the apex, ca. 75-130 μ wide at the base near the insertion, in cross-section showing a median row of about 6-9 guide cells with bands of stereid cells above and below, outer cells differentiated on both sides; cells of lamina at mid-leaf rather thick-walled, mostly about 6.5 μ in diameter, round or angled, on some leaves averaging smaller, smooth or minutely papillose dorsally, bulging to sharply mammillose ventrally, especially in the upper ⅓ of the leaf; cells of the leaf base larger, ca. 15(-20) × 55(-65) μ, hyaline, rapidly decreasing in size upward and imperceptibly grading into the smaller, green cells above; *teniolae extending from near the leaf base to just below the apex, usually 2-3 cells in from the margin or forming the margin here and there*, sometimes absent below mid-leaf and occasionally interrupted, *very stout*, (2-3)4-5(-12) cells wide, *often with jagged offshoots toward the costa in the upper part of the leaf*, more or less oval in cross-section and composed of stereid or substereid cells; *propagula*, if present, *abundant, brownish, multicellular, ovate to oblong*, up to 150 × 360 μ, *borne on filamentous stalks along the stem between the leaf bases*. Perichaetial leaves about ½ the size of the stem leaves and usually lacking the teniolae. Probably dioicous. Sporophytes unknown.

TYPE: *E. G. Britton* 5206, on wet rocks, vicinity of Utuado, Puerto Rico, 7-10 March 1915, (NY). DISTRIBUTION: Known from one other collection, besides the type, in PUERTO RICO: *E. G. Britton* 3983 (paratype), on rock in stream, La Juanita near La Marias, 7 Feb. 1915, (NY), and from one collection from HAITI: *G. V. Nash* 666a, mixed with *Fissidens*, muddy and wet, Plaisance to Marmelade, about 2500 ft., 23 Aug. 1903, (NY).

This is a well marked and interesting species of rather uncertain affinities. The habit of the plants plus the presence of the stalked propagula along the stem (strongly suggestive of *Barbula crucgeri* Sond.) lead me to believe that it belongs in the Pottiaceae subfamily Trichostomoideae. The shape of the leaves and their appearance in cross-section are in agreement with this classification. Discovery of the sporophyte would settle the matter at once. Williams assigned the species to *Calymperes* solely on the basis of the teniolae and, as significant as these structures are, being known

up to now only from the Calymperaceae, I consider their presence inadequate in this case to permit the retention of the species in *Calymperes*. The three most convincing reasons for excluding the species from *Calymperes* are the complete lack of cancellinae; the presence along the stem of stalked propagula (not mentioned in the type description); and the strong, upwardly irregular teniolae differing in structure from those of true *Calymperes*. The presence of cancellinae is an established characteristic of *Calymperes*, and their absence in this case is more significant when coupled with the other differences. Similarly, throughout the Calymperaceae where propagula are present they are of a distinctive form, clavate or filiform, and borne mostly at the leaf tips or occasionally along the ventral surface of the costa, a situation quite at variance with the present case where the propagula are oblong, stalked, and borne along the stem. Finally the teniolae of this species are heavily thickened ridges running along just inside the margins of the leaves, and are quite without the areas of elongated, thick-walled, hyaline cells such as comprise parts of the teniolae of *Calymperes*. Furthermore, the upper parts of these teniolae show jagged irregularities jutting toward the costa, which are unknown in *Calymperes*. Dr. Howard Crum has suggested (*in lit.*) that this species might be referred to the genus *Hyophila*, inasmuch as the shape of the leaves and the nature of the leaf cells and the propagula are suggestive of *H. tortula*. Also it is germane to mention in this connection the genus *Morinia* which, because of its thickened leaf margins, might also be considered as a possible repository for the species. However, I do not believe that this moss could be classified satisfactorily in either of the genera mentioned above: in the case of *Morinia*, the leaves are thickened marginally rather than intramarginally, and in addition are lanceolate, acute, and densely papillose above; and it seems unwarranted to stretch the concept of *Hyophila* to include a species with such distinctive structures as teniolae. It is impossible (and unnecessary) to set arbitrary standards for the delimitation of genera or other evolutionary units. Each case must be decided by the systematist on the basis of his own special knowledge of the group in question. In the present case the teniolae, together with the propagula and the other characteristics of the species, form a unique combination of characters quite worthy of recognition on the generic level.

The two collections from Puerto Rico agree perfectly in all details, and the one from Haiti, although more delicate and lacking propagula, is obviously the same species. Both of the Puerto Rican specimens are sterile; the Haitian one bears archegonia.

TWO NEW SPECIES OF PTYCHOMITRIUM FROM SOUTH AFRICA

HAROLD ROBINSON[1]

In a small collection of South African bryophytes obtained by Dr. R. K. Godfrey early in 1953, I encountered two specimens of *Ptychomitrium* which I was unable to determine satisfactorily. A number of distinctive characters, especially in the leaf cross-section, were observed which were not included by Sim (1926) in his treatment of the genus. After examining material borrowed from the New York Botanical Garden and the Conservatoire et Jardin botaniques, Genève, and reviewing Müller's type descriptions of a number of species it was evident that Godfrey's collections represented two previously undescribed species.

The type specimens of the new species are in the Duke University Herbarium with additional specimens in the herbaria of Florida State University, the National Museum of Canada, the New York Botanical Garden, and the United States National Herbarium. For the preparation of the Latin diagnoses the aid of Mr. Thomas M. Simkins, Jr., of the Duke University Library staff is gratefully acknowledged.

Ptychomitrium godfreyi sp. nov.[2] Plants low, densely cespitose, about 0.5 cm. high, light green. Stems simple or little branched. Leaves tightly crisped, when moist erect-spreading, 2.5 mm. long, subulate, usually narrowed toward both the base and apex, margin entire, lamina unistratose throughout. Costa smooth and yellowish on the back, narrow at the base, becoming broadest above the middle, narrowing distally and disappearing just below the ± acute apex. Basal leaf cells large, 12-15 μ × 20-40 μ, narrow on the margin; upper leaf cells smaller, 11-14 μ, subquadrate, chlorophyllose. Plants autoicous. Setae solitary or paired, pale yellow, 3 mm. long. Capsule erect, cylindrical, about 1 mm. long. Annulus present. Operculum rostrate. Calyptra mitrate, covering

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[2] Cespites humiles densi, ca. 0.5 cm. alti, virides. Caules simplices vel parce divisi. Folia siccitate coarctata, madore erecto-patentia, 2.5 mm. longa, subulata, fere angustiora et ad basim et ad apicem, margine integrâ, omnino unistratosa; costa dorso laevis et subflava, ad basim angustior, super medium latissima sed ad apicem plus minus acutum angustior et evanida; cellulae basilares 12-15 μ × 20-40 μ, in margine angustae; cellulae superiores 11 × 14 μ, subquadratae, chlorophyllosae. Planta autoica. Setae solitares vel binae, gilvae, 3 mm. longae. Theca erecta, cylindricalis, ca 1 mm. longa. Adest annulus. Operculum rostratum. Calyptra mitrata, majorem partem thecae investiens. Peristomium simplex, dentibus lanceolatis, plus minus hebetibus, ad apicem bifidis, fere pallidis sed ad basim subrubellis, dense papillosis. Sporae gilvae, sphaericae, 7-8 μ, minutissime asperae.

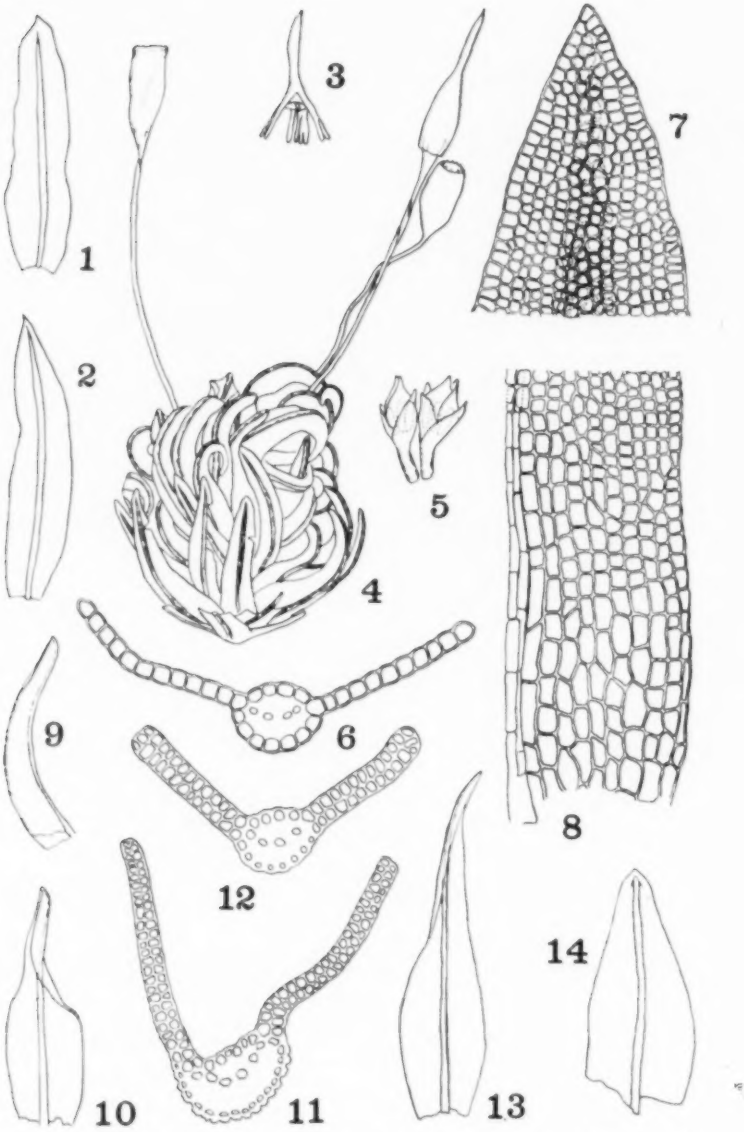

FIG. 1-8. *Ptychomitrium godfreyi*. 1-2. Leaves, × 19. 3. Calyptra, × 10. 4. Plant with sporophytes, × 10. 5. Perigonia, × 19. 6. Cross-section of

most of the capsule. Peristome simple, with teeth rather lanceolate, bifid in the apical half, pale with rather reddish bases, densely papillose. Spores pale yellow, spherical, 7-8 μ, minutely roughened. (Fig. 1-8.)

On rocks in thorn-acacia woodland, alt. 3500 ft., 25 mi. NE. of Ladysmith, Natal, South Africa, Feb. 20, 1953, *R. K. Godfrey*.

From Sim's key and description this species might be mistaken for *P. crassinervium*. According to Müller's original description of that species, however, it differs by having the costa widest at the base and by having a linear acumen.

Ptychomitrium exaratifolium sp. nov.[3] Plants low, densely caespitose, about 0.7 cm. high, yellowish-green. Stems simple or little branched. Dry leaves loosely circinate-crisped, when wet erect-spreading, 3 mm. long, lanceolate from a broad obovate base, margin entire. Costa becoming gradually narrower from the base and disappearing in the cucullate apex, smooth and yellow on the back. Leaf base vaginate, with cells lax, hyaline, subrectangular, 15-20 μ × 60-80 μ, narrower toward the margins, unistratose; cells of the shoulders and lamina of the leaf smaller, subquadrate, 5-10 μ, chlorophyllous, in two layers, the upper surface with longitudinal furrows between the rows of cells. Plants autoicous. Setae solitary, reddish, 3 mm. long. Capsule erect, ovoid, about 1 mm. long. Annulus present. Operculum long-rostrate, about 0.7 mm. long. Calyptra mitrate, covering most of the capsule, occasionally cucullate. Peristome simple, with teeth reddish, lanceolate, densely papillose, usually smooth and narrowly bifid apically. Spores reddish-yellow, 20-30 μ, ellipsoid, finely roughened. (Fig. 15-22.)

[3] Cespites humiles densi, ca. 0.7 cm. alti, flavo-virides. Caules simplices vel parce divisi. Folia siccitate laxe circinato-crispata, madore erecto-patentia, 3 mm. longa, lanceolata, e basi latâ et obovatâ, margine integrâ; costa sensim e basi angustior et in apice cucullato evanida, dorso laevis et flava; basis vaginata, cellulis laxis, hyalinis, subrectangularibus, 15-20 μ × 60-80 μ, ad margines angustioribus, unistratosa; cellulae in basi superiore et laminâ parvae, subquadratae, 5-10 μ, chlorophyllosae, in stratis duobus compositae; superficies superior folii sulcos longitudinales inter ordines cellularum habet. Planta autoica. Setae solitares, rubellae, 3 mm. longae. Theca erecta, ovoidea, ca. 1 mm. longa. Adest annulus. Operculum longe rostratum, ca. 0.7 mm. longum. Calyptra mitrata, capsulam paene investiens, interdum cucullata. Peristomium simplex, dentibus rubellis, lanceolatis, dense papillosis sed ad apicem laevibus et bifidis. Sporae melino-succinaciae, ellipsoidales, 20-30 μ longae, asperulae.

leaf, × 140. 7. Cells of leaf tip, × 140. 8. Cells of leaf base, × 140. Fig. 9-11. *P. cucullatifolium*. 9-10. Leaves, × 19. 11. Cross-section of leaf, × 140. Fig. 12-13. *P. crispatum*. 12. Cross-section of leaf, × 140. 13. Leaf, × 19. Fig. 14. *P. obtusatum*, leaf × 19.

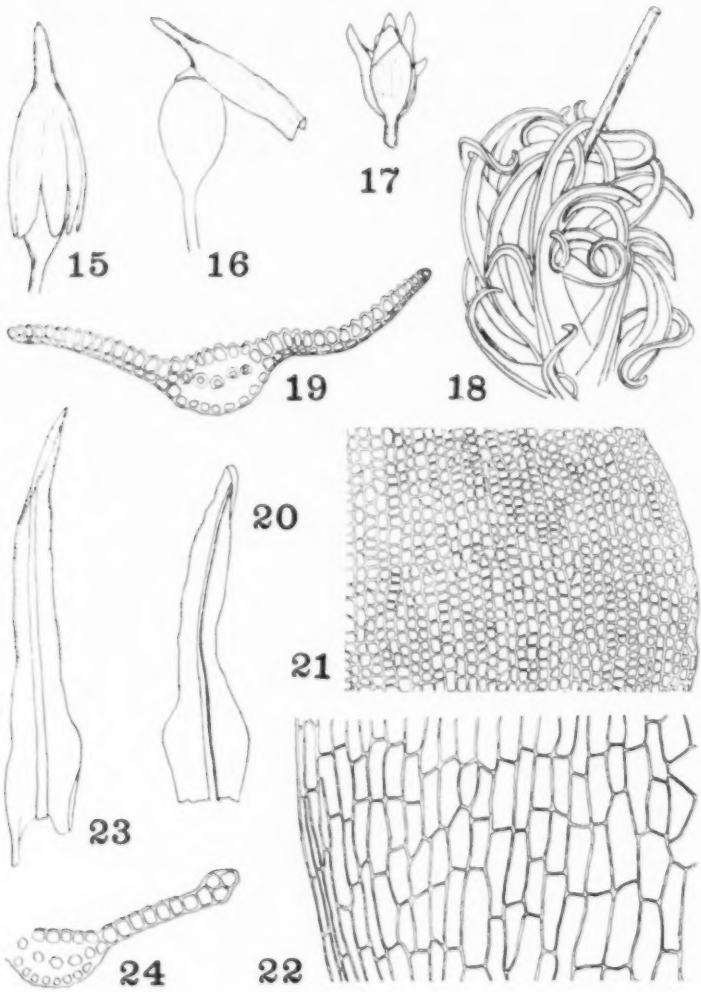

FIG. 15-22. *Ptychomitrium exaratifolium*. 15-16. Capsules with calpytrae, × 19. 17. Perigonium, × 19. 18. Plant with base of seta, × 19. 19. Cross-section of leaf, × 140. 20. Leaf, × 19. 21. Cells of leaf shoulder, × 140. 22. Cells of leaf base, × 140. FIG. 23-24. *Ptychomitrium marginatum*. 23. Leaf, × 19. 24. Cross-section of leaf, × 140.

On open doleritic boulders, alt. 2000 ft., Ship Mountain in the vicinity of Pretorius Kop, Kruger National Park, Transvaal, South Africa, Jan. 15, 1953, *R. K. Godfrey*.

The longitudinal furrows on the ventral surface of the leaf are a distinctive feature, but, in addition, no other species of the genus has the combination of the cucullate leaf apex and the broad clasping leaf base.

In the course of reviewing the South African species of *Ptychomitrium* it was necessary to consider *P. obtusatum* (C. M.) Par., which Sim, without seeing the type, had concluded was a form of *P. crispatum*. Through the kindness of Dr. C. E. B. Bonner, the type of *P. obtusatum* from the Conservatoire et Jardin botaniques, Genève, was available for study. In most characters, including leaf cross-section, the species was like *P. crispatum*. The differences were that the leaf lamina was shorter and broader, the apex was distinctly though not strongly cucullate, and the costa was distinct into the cucullate tip.

The following key is provided to summarize the distinctions between the known South African species of *Ptychomitrium* and to introduce some newly observed characters.

1. Basal leaf margins strongly revolute, leaves not cucullate, costa filling the subulate tip..... *P. depressum* (C.M.) Par.
1. Basal leaf margins plane or if sometimes slightly recurved the leaf tip cucullate, costa not filling the leaf tip..... 2
2. Leaves bistratose in the apical half..... 3
3. Upper surface of the leaves with longitudinal furrows between the rows of cells (Fig. 19)..... *P. exaratifolium* Rob.
3. Leaf without furrows on the upper surface..... 4
4. In cross-section the cells of the back of the costa with conspicuously thickened outer walls (Fig. 11.)..... *P. cucullatifolium* (C.M.) Jacg.
4. In cross-section the cells of the back of the costa with uniformly thickened walls (Fig. 12.)..... 5
5. Leaves relatively short and broad, costa extending into a slightly but distinctly cucullate apex (Fig. 14.)..... *P. obtusatum* (C.M.) Par.
5. Leaves lanceolate, broad only in the basal part, becoming indistinct before the acute apex (Fig. 13.)..... *P. crispatum* (Hook. & Grev.) Schimp.

2. Median leaf cells in one layer, margins sometimes bistratose..... 6
6. Median leaf cells 6-10 μ across, margins bistratose..... 7
7. Seta short, ca. 3 mm. long, capsule ovoid..... *P. subcrispatum* Thér. & P. de la V.
7. Seta ca. 7-12 mm. long, capsule cylindrical..... *P. marginatum* Wag. & Dix.
6. Median leaf cells 10-16 μ across, margins unistratose..... 8
8. Leaf and costa broader near the middle than at the base..... *P. godfreyi* Rob.

8. Leaf and costa broader at the base than near the middle..... 9
9. Leaf abruptly narrowed from a wide base.....*P. curybasis* Dix.
9. Leaf gradually narrowed from near the base.....
.....*P. crassinervium* (C.M.) Jaeg.

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SIM, T. R. 1926. The Bryophyta of South Africa. Trans. Roy. Soc. South Africa. 15: 1-475.

TAXONOMIC NOTES. XIV. THE DIOICOUS FORM OF MNIUM CUSPIDATUM

A. LEROY ANDREWS[1]

Mnium cuspidatum (L.) Leyss., a common species of Europe and North America, has regularly been regarded as synoicous. Among a large amount of this and other *Mnium* material from Illinois sent me for naming by Dr. L. F. Koch of the University of Illinois was a collection of obviously dioicous *M. cuspidatum*, which raises some questions or recalls them to attention. The collector was Virginius H. Chase of Peoria Heights, Illinois, who says he is not a bryologist. Attempts to get living material to Dr. R. J. Lowry for cytological study of the chromosomes appear not to have been successful as yet. The locality was given as "in spring-fed bog, near Spring Bay, Woodford County, Illinois," May 21, 1953, and the collection was unusually well made. The material was in good condition, in five packets under five numbers, the separation apparently made already by the collector. In addition to two packets (1 and 2) labeled "on earth," one each are labeled "on decayed vegetation" (3) and "on decayed bark" (4) and a final one (5) "on earth and decayed vegetation." Of these nos. 1 and 3 are made up entirely of archegonial plants, no. 5 entirely of antheridial plants, all of these without sporophytes. No. 2 is a combination of both ♀ and ♂ plants and bears sporophytes. No. 4 is on the whole less well developed or at any rate less erect and elongated and shows very few antheridial heads and no sporophytes. The plants reveal clearly the effects of the wet conditions under which they grew, being, apart from those growing on bark, almost exclusively elongated and erect, from two to four centimeters in height. ♂ and ♀ plants are also appreciably differen-

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tiated, the ♀ ones having larger and more numerous leaves, more closely placed on the stem, the terminal leaves not especially differentiated. The ♂ plants have smaller leaves, farther apart, and are terminated by a large antheridial head subtended by large perigonial leaves with broad base. As to the inflorescence, the archegonia are not numerous, their paraphyses few and finely filiform. The antheridia on the other hand are very numerous and are accompanied by numerous slenderly clavate paraphyses, the cells of the latter from a slender base becoming progressively broader and at the same time shorter, the terminal cell quite short and generally slightly less broad than the two below it. In the specimens examined the paraphyses overtopped the antheridia by two or three cells. Apart from the inflorescence no particular differences between these plants and normal *M. cuspidatum* were noted. The leaves were of the same type, very decurrent, the leaf cells of normal size and with thickened corners, the leaf border quite normal. The sporophytes were also normal.

A question of especial interest raised by the plants is the chromosome number, for the determination of which living material is of course necessary. The suggestion of Heitz,[2] worked out in greater detail by Lowry,[3] would postulate a number $n = 6$ for dioicous *M. cuspidatum* compared with the known number $n = 12$ for normal synoicous *M. cuspidatum*. Lowry did in fact study a Florida specimen which showed six chromosomes, which he inferred was dioicous, though it completely lacked inflorescence. Heitz had conjectured that the need might be met by *M. Trichomanes* Mitt., a dioicous species of Japan and eastern Asia, closely related to *M. cuspidatum*, of which it was made a subspecies by Kabiersch.[4] Study of the chromosomes of this Asiatic species was apparently unknown to both Heitz and Lowry at the time of their publications. Lowry established among the American species four pairs showing the relationship dioicous haploid versus synoicous diploid:[5] *M. orthorhynchum-marginatum*, *M. affine-medium*, *M. punctatum-pseudopunctatum*, and *M. cuspidatum* with its dioicous mate represented by the sterile Florida form, which, if found in more complete condition, he stated should constitute an independent species. It should be added that Lowry found two species which did not conform to this principle, namely *M. Drummondii* and *M.*

[2] Arch. Julius Klaus- Stift. Vererb., Sozialanth. Rassenhyg. 27: 444 ff. 1942.

[3] Mem. Torr. Bot. Club 20(2). 1948.

[4] Hedwigia 76: 34. 1936.

[5] I am using terms haploid and diploid as employed by Lowry instead of diploid and tetraploid often adopted by later authors.

spinulosum, both normally synoicous haploids. Neither does the principle apply consistently in other genera studied cytologically.

The question naturally arises whether isolated American specimens of dioicous *M. cuspidatum* should not be referred to *M. Trichomanes*, whether the latter be treated as species, subspecies, or variety. I have studied several Japanese specimens of this latter taxon including two issued by Noguchi in his exsiccati series and three additional ones sent by him recently. All of these seem to represent a consistent form, differing hardly from *M. cuspidatum* except in inflorescence and perhaps slightly smaller size of leaf cells, which accounts for Kabiersch making it a subspecies only. It is noteworthy that Kabiersch found the subspecies abundantly represented in eastern Asia including Japan, while he listed very few specimens of his subspecies *cucuspidatum* from this region, only one definitely from Japan. His drawing of the "Zellnetz" of the *cucuspidatum* leaf does not correspond to the normal leaf areolation of the species in Europe and North America, which is, apart from the possible question of size, like that of his subspecies *Trichomanes*. I have only a single Japanese specimen labeled *M. cuspidatum*, sent me long ago by Ishiba, but it is wrongly named and is apparently according to the treatment of Kabiersch *M. japonicum* Lindb. I applied to Professor A. Noguchi, whose critical work on the mosses of Japan is outstanding, for his opinion and any information he could furnish me on this *Mnium* group. He informs me that he now regards *M. Trichomanes* as a variety only of *M. cuspidatum*, distinguished solely morphologically by inflorescence, the difference in size of leaf cells being negligible. Of especial interest is a specimen sent me by Noguchi collected by K. Yano, who has published extensively on the cytology of Japanese mosses, which bears the notation, "n = 7" (unpublished, according to Noguchi). According to the list of chromosome numbers of mosses published by Ann P. Wylie in Transactions of the British Bryological Society (3: 270. 1957), the chromosomes of the Japanese *M. Trichomanes* had been determined already in 1939 by Kurita as 6, later in 1951 by Tatuno as 7. However one may explain the one extra chromosome (7 instead of 6), which both Heitz and Lowry and others have found in some other *Mnium* species, the supposition of Heitz that *M. Trichomanes* is a haploid species as contrasted with the normal diploid *M. cuspidatum* seems fully confirmed. Noguchi further informs me that the *Trichomanes* variety is widely distributed in Japan, while the normal *cuspidatum* form is rare and confined to northern areas. Putting together the available facts, it would look as if the normal

M. cuspidatum is, as always recognized, the almost exclusive form of North America and Europe, but rather uncommon in eastern Asia, while the dioicous *M. Trichomanes* is the regular Asiatic, or at any rate eastern Asiatic form, but occurs only extremely rarely in North America (and Europe?). Perhaps it has been passed over in the two latter continents and, if definitely searched for, will be found better represented than present literature indicates.

As to whether *M. Trichomanes* should be considered a species, subspecies or variety, the question is bound up with that of naturally occurring polyploidy. Is a natural diploid a separate species while the same diploid produced artificially by regeneration from the sporophyte of the haploid species is not a species? Lowry would argue that the natural diploid (autodiploid) is a fully justified species, that is, that the North American dioicous haploid of *M. cuspidatum* should be given specific status. He did not definitely associate it with *M. Trichomanes*.

In connection with these closely related pairs of *Mnium* species I have been justly criticized for inconsistency in my treatment of *Mnium* in Grout's *Moss Flora* in that I have there recognized as separate species dioicous *M. affine* and synoicous *M. medium*, dioicous *M. orthorhynchum* and synoicous *M. marginatum*, while I reduced the synoicous *M. pseudopunctatum* to the dioicous *M. punctatum*. From present knowledge and accepting the present tendency to treat naturally occurring polyploids, if separated by any morphological differences, as valid species, *M. pseudopunctatum* should be so recognized. Its chromosomes had not yet been counted in 1940 and morphological points of separation, apart from the inflorescence, are somewhat variable. Kabiersch suggested *M. pseudopunctatum* is perhaps rather a subarctic variety and quoted Hampe to the same effect. In all of these species pairs the natural assumption that the dioicous haploid is the older form could account for its greater variability, which has led to segregation of additional species that are not in all cases wholly clear.

STUDIES ON HEPATICAE. I. TEMNOMA

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The concept of genus in the Hepaticae is still in an unsatisfactory state. This is, in many instances, the result of too superficial study of the plants, particularly of the type species. In this,

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and succeeding papers, I propose to clarify the systematics of especially the leafy Hepaticae by detailed morphological and anatomical investigations of critical genera.

The genus *Temnoma* of Mitten is such a genus. It was described by Mitten (*in* Hooker, 1867, p. 753). Mitten assigned to it only two species, *T. pulchellum* (Hook.) Mitt. and *T. quadrifidum* (Mitt.) Mitt. In view of the fact that *T. pulchellum* was the first of these species cited, I propose it be considered the generitype. Since Mitten's diagnosis was a very model of brevity ("Perianth above 3-gonous, truncate") and his diagnosis of the two species he proposed was hardly more elaborate, the genus has been a considerable problem: some workers have considered it a synonym of *Blepharostoma* (*i.a.*, Schiffner, 1893-95; Stephani, 1909; Müller, 1954 *in* 1951-57); other workers have assigned to it the wholly unrelated "*Chandonanthus*" *setiformis* (Howe, 1902; Evans, 1923; Frye & Clark, 1946, etc.); finally one worker (Hattori, 1952) has recently assigned the quite unrelated, typical species of *Chandonanthus*, such as *C. birmensis* and *C. hirtellus* to *Temnoma*. As a consequence, I was wholly uncertain as to the following questions: Is *Temnoma* actually a synonym of *Chandonanthus* or *Blepharostoma*, as maintained by a variety of workers? Since these two genera belong, respectively, to the Lophoziaceae and Blepharostomaceae, to which family should *Temnoma* be assigned? Preliminary study of the generitype of *Temnoma* immediately poses a third, even more critical question: Is the family Blepharostomaceae a "natural" family? These three questions, and others that arose as the study progressed, are to be answered on the following pages. Resolution of these questions is a prerequisite to revisionary studies under way on the species of these groups.

1. TEMNOMA PULCHELLUM (Hook.) Mitt. *in* Hook., Fl. N. Z. 753. 1867. *Blepharostoma pulchellum* (Mitt.) Steph., Sp. Hep. 3: 640. 1909. Plants rather robust, 3.2-3.5 mm. wide, to 4 mm. near apices of fertile shoots, suberect to loosely prostrate, yellowish-brown, very sparingly branched, the branches lateral and (always?) terminal, of the *Frullania*-type, replacing the ventral half of a lateral leaf. Stems ca. 250-300 μ high × 320-360 μ broad, brownish, somewhat *translucent, relatively soft;* cortical cells in 1-2 layers somewhat smaller in diameter than medullary, ca. 17-23 μ in diameter, *only slightly thick-walled*, quadrangular to polygonal in cross-section, not tangentially flattened, *strongly elongated and rectangulate*; medullary cells in 8-10 tiers, leptodermous, with angles slightly thickened, 25-36 μ in diameter; without fungal infection of the stem. Leaves ca. 1550 μ wide (without cilia; with cilia 2650 μ) × 1000 μ

long (with cilia 1600 μ), somewhat larger on fertile shoots. Leaves of sterile shoots moderately imbricate, *distinctly succubously inserted* (angle 35-45° from transverse), on upper parts of fertile shoots becoming denser and subtransverse, *transversely obtrapezoidal to reniform in outline*, somewhat narrowed to the base, *symmetrically quadrilobed for 0.35-0.45 their length* (with a weak tendency for the elaboration of an accessory lobe of the antical and postical margins), the *lobes and antical and postical margins sharply and conspicuously longly setose-ciliate* with stiff, setiform cilia 300-650 μ long, formed of generally 5-8 strongly elongated, thick-walled, rigid cells; cells of cilia 75-100 μ long × 10-12 μ wide (in upper, tapering portions of cilia) to 22-25 μ wide (in lower portions of cilia); sinuses somewhat rounded at base and narrowly but sharply reflexed. Lobes and undivided portions of leaves formed of slightly or hardly thick-walled, *strongly elongated cells, partially aligned in regular tiers*, the cells in the lobes and leaf middle averaging 18-23 μ wide × (55) 60-80 (90) μ long; cuticle smooth. Underleaves quite large, but *averaging ca. one-half the size of the lateral leaves*, similar in shape to lateral leaves and *quadrifid* like them, the margins similarly spinescent; underleaf size ca. 950 μ wide (without cilia; 1850 μ with cilia) and 500 μ long (without cilia; with cilia 1000 μ). Rhizoids in distinct fascicles at the bases of the majority (sometimes all) *of underleaves, absent from the stem*, long and brownish, irregularly palmate or dendroid at the apices. *Asexual reproduction lacking.*

Dioecious? Androecia *becoming intercalary* on leading, leafy shoots, formed of 6-10 or more pairs of rather closely imbricate bracts, somewhat more slender than vegetative portions of shoots (600-700 μ wide, without spines; 1900-2000 μ wide, with spines); bracts *ventricose*, somewhat spreading at base and the undivided portions then erect, only the 3-4 short lobes spreading to squarrose; lobes and margins near them strongly spinose-ciliate with setose cilia similar to those of the leaves. Antheridia (largely absent in material available) apparently 1-2 per bract; stalk apparently 2-seriate. Gynoecia terminal on leading shoots, without innovation. Bracts erect and sheathing, quadrifid (or 5-6 lobed) like the leaves, the sinuses more strongly reflexed, the margins of the lobes and undivided leaf bases setigerous or spinescent like the leaf margins; bracteole virtually like bracts. Perianth cylindrical, only weakly narrowed distally, the mouth rather broad and truncate, densely setigerous and spinescent, similar to the leaf and bract margins; perianth terete below, strongly *3-plicate* above, the plicae rounded; perianth composed of somewhat thick-walled, strongly elongated cells.

Sporophyte with seta 150-165 μ in diameter, formed of *19-20 rows of slightly larger epidermal cells* that are distinctly collenchymatous, with thin interior walls but obviously thickened angles; inner cells in numerous rows, in 3-4 concentric tiers (seta thus 9-10 cells across); epidermal cells *23-27* μ in diameter; inner cells 16-20 μ in diameter. Capsule very firm, ovoid-cylindrical, about 2-2.5 times as long as broad, reddish-brown; *valves straight*, firm. *Capsule-wall 4-5 stratose*, ca. 40-50 μ thick; *epidermal cells very large, pellucid, colorless* and devoid of thickenings (except in 2-3 rows adjacent to sutures, where with strong nodular thickenings), irregularly quadrangulate, 16-20(23) μ thick × (25) 35-50(60) μ wide, as thick as (or thicker than) the two layers within combined; hypodermal layers of rectangulate, narrower cells, ca. 10 μ thick, with numerous reddish-brown nodular thickenings; innermost 2-3 layers somewhat variable in thickness; when with only 2 inner layers, these respectively 5-6 and 7 μ thick; when with 3 inner layers, the outer ca. 7 μ thick, the inner two 4-5 or 5-6 μ thick; inner layers with numerous nodular to semiannular bands. Elaters rather sparingly produced, short and rather thick, bluntly pointed at the weakly tapering ends, 7.5-8.5 μ in diameter × 80-100 μ long, somewhat contorted, closely bispiral, like reddish spirals ca. 3 μ wide. Spores translucent, pale brown, weakly verruculose, 8.5-9.5 μ in diameter, *their diameter subequal to that of elaters*.

The above diagnosis of the generic type holds largely for the genus *Temnoma* with regard to the gametophytic features. The perianth-bearing plants of *T. quadrifidum* available to me agree in basic stem anatomy but differ from *T. pulchellum* largely in the leaves and underleaves more nearly similar in size; cilia less spinescent; green color and smaller size; laxer leaves; and large perianths broader, hardly narrowed, and more obtusely plicate—the plicae being three chief ones, obscured by 1-2 accessory, weak ones. Both species show a distinctly succubous leaf insertion. These typical species of *Temnoma* appear to differ in leaf insertion from the Patagonian *T. pilosum* and *T. quadripartitum*, both of which seem to possess nearly transversely inserted leaves (Evans, 1898); Evans' illustrations (loc. cit., pl. 345) at least strongly suggest that the leaves are almost transversely inserted. It remains to be demonstrated, however, that the insertion is ever really transverse and not weakly succubous; every species properly belonging in the genus has at least somewhat succubously inserted leaves, according to my investigations. Since I regard leaf insertion and orientation as a major (family) criterion, this is a point which needs to be clearly established.

The species of *Temnoma* with which I am familiar all agree in having symmetric leaves. A like symmetry exists in *Blepharostoma* and in species currently assigned to *Lepicolea* (*L. fryei* Pers.) or *Blepharostoma* (*B. quadrilaciniatum*), but which form a third, undescribed genus (to be described elsewhere as *Lophochaete* gen. n.). Symmetric lobing of the leaves thus appears to characterize all species correctly referable to the Blepharostomaceae. Similarly characteristic is the restriction of the rhizoids to the bases of the underleaves. In *T. pulchellum* these are particularly frequent, forming a distinct brownish group at the bases of the majority or all of the underleaves. Finally, the cilia or teeth of the leaves in all true species of *Temnoma* are multicellular.[2]

So far as I am aware, the sporophyte of *Temnoma* has never been described and therefore warrants comment. Its anatomy, as is pointed out, is exceedingly similar to that of *Trichocolea*, although the latter has 5-6 strata of cells bearing thickenings, within a large, pellucid layer of unpigmented, thin-walled epidermal cells. In *Temnoma* there are only 3-4 such strata of cells bearing thickenings within the layer of thin-walled epidermal cells. This difference is only of minor significance. The capsule wall shape in the two genera is identical. Both possess a relatively complex seta, although that of *Trichocolea* consists of a very large number of small epidermal cells (65-80 approximately) surrounding numerous inner cell rows, of which the innermost disintegrate with maturation, resulting in a hollow seta. Both *Trichocolea* and *Temnoma* appear constantly to have small spores, less than 1.8 times the diameter of the elaters.

In addition, *Temnoma* and *Trichocolea* agree in the noncollenchymatous cells, in the narrowly rectangulate and hardly thick-walled cortical cells of the stem, and in the succubous leaf insertion. In both genera the leaf lobes and underleaf lobes are typically four, with occasional weak accessory lobes produced; the lobes are freely ciliate. Branching, furthermore, appears to be normally of the *Frullania*-type. In some other species of *Temnoma* intercalary branching has been found, although branching is probably never entirely intercalary. (In a revision of the genus, under preparation, the differences in branching pattern within the genus will be discussed.) One is therefore strongly tempted to suggest a close affinity between the two genera. The other features of the two genera, however, belie any close affinity. The absence of a perianth

[2] It should be noted that the two species previously assigned to "*Blepharostoma*" which possess asymmetrically trifid leaves and cilia formed of highly differentiated single cells do not belong either to *Temnoma* or to *Blepharostoma*; for one of them *Herzogianthus* has been proposed.

in *Trichocolea*, which is replaced by a "stem-perigynium" formed by the developing sporophyte that literally appears to "bore" into the stem tip, is wholly unique. In addition, the lateral leaves are distinctly asymmetrically lobed, and the plants possess freely 1-2-pinnate branching. It is therefore certain that no immediate relationship to *Temnoma* exists. Nevertheless, the persistent idea intrudes itself that perhaps the derivative Trichocoleaceae may have evolved from *Temnoma*-like ancestral forms. Surely the almost unique capsule wall anatomy must be regarded as very suggestive.

2. The Status and Position of Temnoma. Detailed study of fertile plants of *Temnoma pulchellum* and of sterile plants of *T. quadrifidum* brings out a series of important generic (and, in some instances, familial) criteria which had been previously uninvestigated. These, in general, are set in italics in the preceding diagnosis. Among the most important criteria of the genus are the following: (1) Capsule wall 4-5-stratose, with the epidermal cells forming a large hyalodermal stratum; (2) perianth trigonous; (3) rhizoids restricted sharply to the basal portions of the underleaves, lacking from the stem; (4) seta of numerous rows of cells; (5) stem with narrowly rectangulate cortical cells not differentiated as a thick-walled, short-celled cortex; (6) underleaves somewhat smaller than lateral leaves; (7) spores and elaters subequal in diameter; (8) branching lateral and evidently terminal, sparse and monopodial; in some species also with intercalary branching. (9) leaves and underleaves both quadrifid; (10) leaf cells noncollenchymatous, strongly elongate and rectangulate, much like the cortical stem cells (although broader); (11) leaves distinctly succubously inserted; (12) leaves with margins sharply spinescent or ciliate-setigerous, although in some species with the cilia or teeth reduced.

Of the above criteria nos. 2, 7, 8, 9, and 10 clearly suggest that *Temnoma* belongs in the vicinity of *Blepharostoma*, hence in the Blepharostomaceae. However, Müller (1954) diagnosed the Blepharostomaceae as follows: "Very delicate plantlets only ½-1 cm long. Leaves divided to base into four hair-like uniseriate bristles. Underleaves as large as leaves, mostly 2-3-setose. Oil-bodies present. Antheridial stalk 1-seriate. Perianth . . . obtusely trigonous above. Seta in cross-section with 4 interior—surrounded by 8 larger and thick-walled epidermal cells. Spores as thick as elaters. Capsule oval, the wall 2-stratose. Gemmae rare, 1-celled."

Temnoma therefore differs from both *Blepharostoma* and the diagnosis of the Blepharostomaceae in a whole series of criteria, including nos. 1, 4, 6, 11 and 12 cited above. In addition, *Tem-*

noma is a much more robust plant; the antheridial stalk appears to be 2-seriate, although the available plants do not allow a certain determination of this; the plants lack gemmae; and the leaves are at least somewhat succubously inserted. The writer believes that the capsule wall anatomy alone is sufficient to preclude considering *Blepharostoma* and *Temnoma* as congeneric, the thin capsule wall of *Blepharostoma*, with the two cell layers subequally thick (ca. 10 μ each) and both bearing thickenings, serving effectively to separate *Blepharostoma* generically from *Temnoma*. Indeed, the only parallel to the capsule wall anatomy found in *Temnoma* among related families is found in *Trichocolea*, the type genus of the Trichocoleaceae.

Other features in addition to the capsule wall anatomy also suggest *Trichocolea*, among them: the succubously inserted, ciliate-lobed leaves; the narrow cortical stem cells; the low spore-elater diameter ratio; the quadrifid and ciliate underleaves that are smaller than the lateral leaves and have the rhizoids restricted to their bases. In spite of these similarities, *Temnoma* still appears more closely related to *Blepharostoma*, with which it shares a similar perianth. (*Trichocolea* lacks a perianth, possessing a paraphyllose stem perigynium.)

If *Blepharostoma* and *Temnoma* are to be united in a single family, a course which seems reasonable to the writer, the Blepharostomaceae will need redefinition. Also to be included in this family, as a third, as yet undescribed genus, are the transverse-leaved plants, with quadrifid leaves and a 4-5-plicate perianth, which have been variously assigned to *Lepicolea* and *Blepharostoma* (Schiffner, 1912; Persson, 1946). These plants include "*Blepharostoma*" *trollii* Herz., "*Blepharostoma*" (or "*Lepicolea*") *quadrilaciniatum*, and "*Lepicolea*" *fryei*. (This element of the Blepharostomaceae is discussed in a contribution appearing elsewhere.)

The preceding discussion has indicated that *Temnoma* is sharply separable from *Blepharostoma*, although assignable to the Blepharostomaceae. This automatically precludes the genus being allied to *Chandonanthus* Mitt., a genus I hope to treat in a future paper. *Chandonanthus* shows three features that are critical in suggesting a very different affinity: the underleaves, which are bifid and much smaller than the lateral leaves, do not have a rhizoid-initial field at their bases, the rhizoids being inserted in a haphazard manner on the stem; the leaf cells are characteristically and very strongly collenchymatous, with strong, nodose thickenings that may be confluent; the stem has a distinct cortex of shortly rectangulate, thick-walled cells. These features suggest the Lopho-

ziaceae, a primitive family of the Jungermanninae (Schuster, 1953), rather than the Ptilidiinae, to which the Blepharostomaceae have been assigned (Schuster, 1953). In this instance, the previously uninvestigated rhizoid-distribution pattern, which was first emphasized as a family criterion by Schuster (1949, p. 115, 1953) gives the most important clue to the position of these plants. This, of course, conclusively demonstrates that the position of Hattori (1952), who would place *Chandonanthus hirtellus* and *C. birmensis* in *Temnoma*, is untenable.

Such an analysis also serves to clarify the position of "*Temnoma*" *setiforme*, an arctic-alpine plant of the northern hemisphere. This species, as shown by Schuster (1951), has a scattered, rhizoid-initial distribution "pattern" and a stem with thick-walled, abbreviated cortical cells, characters it shares with *Chandonanthus* rather than with *Temnoma*. These features, alone, are enough to exclude this species from *Temnoma* but suggest it must be placed in or near *Chandonanthus*. This problem, again, merits future attention.

3. Distribution of the Genus Temnoma. The few species assignable to *Temnoma* all appear to be antipodal in range, with a center of distribution in the region involving the southernmost tip of South America and New Zealand. This distribution pattern, is, of course, a classical one. To date I know of no species definitely described from South Africa, although an extension to South Africa would not be unexpected. The existing ranges of the limited number of species is clear from the following synonymy:

Temnoma pilosum (Evs.) n. comb. *Blepharostoma pilosum* Evs., Bull. Torrey Bot. Club *25*: 413. 1898. Patagonia.

Temnoma quadripartitum (Hook.) n. comb. *Jungermannia quadripartita* Hook., Musci Exot. *2*: Pl. 117. 1820. Fuegia.

Temnoma corrugatum (St.) n. comb. *Blepharostoma corrugatum* St., Hedwigia *32*: 15. 1893. Stewart I., near New Zealand.

Temnoma palmatum (Lindb.) n. comb. *Blepharostoma palmatum* Lindb. *in* Pears., Jour. Bot. *25*: 193. 1887. New Zealand and Australia.

Temnoma pinnatisetum (St.) n. comb. *Blepharostoma pinnatisetum* St., Sp. Hep. *3*: 639. 1909. Patagonia. This may be identical with *Temnoma pilosum* (Evs.) Schust.

Temnoma dusenii (St.) n. comb. *Blepharostoma dusenii* St., Bih. K. Sv. Vet.-Akad. Handl. *26*, III(6): 52. 1900 (1901). Fuegia.

4. Summary. *Temnoma* Mitt., a small genus of about seven species limited to New Zealand, Australia, and Patagonia, is related to the holarctic genus *Blepharostoma*, which has evidently only three species assignable to it: *B. trichophyllum* (L.) Dum., ranging from the polar basin south to the Azores, southern Italy, the Southern Appalachians, southward in the Cordilleras to New Mex-

ico and Arizona, to central China, Japan, and the Himalayas, and to the Caucasus Mts.; *B. minus* Horik., Japan; and *B. arachnoideum* Howe, Pacific Coast.

Temnoma differs from *Blepharostoma* in a whole series of gametophytic and sporophytic features, as well as in the lack of asexual reproduction. Nevertheless, the genus is assignable to the Blepharostomaceae, which must be redefined to include it; sporophytic similarities to the Trichocoleaceae need further investigation. *"Temnoma" setiforme*, *"Temnoma" birmense* and *"T." hirtellum* have scattered rhizoids and a very different stem anatomy, as well as a different leaf areolation; they must be placed in the Lophoziaceae. At least the latter two species clearly belong in *Chandonanthus*, a genus of Indomalayan and antipodal distribution, with extensions in range to Japan and Central Africa.

The present study suggests that the diagnosis of the Blepharostomaceae in Müller (1954) is quite incorrect; it appears to be based on *Blepharostoma trichophyllum* and is hardly a family diagnosis. Although we are scarcely in a position to give a final diagnosis of the group, the following criteria appear to hold:

Plants with branching lateral, axilary, or terminal and of the *Frullania*-type; *branching sparing to rare, monopodial;* stems with cortex *hardly defined*, of not or slightly thick-walled, *narrowly rectangulate cells* commonly 3-8 times as long as wide, the medullary very similar although often slightly larger in diameter and sometimes more leptodermous; leaves *transverse to succubously inserted, never incubous;* leaves *symmetrically* 4-*lobed*, for 0.4-0.95 their length, rarely with accessory lobes above antical and postical bases; underleaves varying from identical in size and shape to lateral leaves to approximately half as large, *similarly* (3-)4-*lobed; rhizoids restricted to underleaf bases;* cells of leaves typically *narrowly rectangulate*, at least in the lobes, without distinct trigones, but sometimes becoming equally thick-walled; pigmentation, if any, light brownish to reddish-brown or rarely blackish-brown; asexual reproduction lacking, or rarely by means of 1-celled gemmae from the leaf-lobe apices.

Usually dioecious. Androecia becoming intercalary; bracteoles like underleaves but *without antheridia;* antheridial stalk 1-2-seriate. Gynoecia terminal on long leafy stems, not innovating. Bracts basically 4(-5)-lobed like leaves, the lobes ciliate or lobed at times; bracteole similar. *Perigynium absent.* Perianth 3- or 4-5-plicate in distal half, somewhat or hardly contracted to mouth. Capsule ovoid to narrowly ovoid, with straight valves; wall 2-5-stratose. Spores small (8-15 μ), *hardly larger in diameter than the bispiral elaters.*

The scope of the family, and the included genera, are discussed in Schuster (1959) and have been dealt with, in outline form, in Schuster (1957).

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CHROMOSOME NUMBERS IN SOME WESTERN HIMALAYAN ACROGYNOUS JUNGERMANNIALES

P. N. MEHRA and R. S. PATHANIA[1]

The leafy hepatics are well represented in the Western Himalayas. There is a report of 91 species belonging to 20 genera from this area by Kashyap and Chopra (1932). Although some of the anacrogynous members of the Jungermanniales of this region have

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been cytologically investigated by Mehra (1938), the leafy hepatics have not attracted the attention of workers. In the present report 10 species have been investigated, all collected from Mussoorie, a hill station in the Western Himalayas at an altitude of 2200 metres.

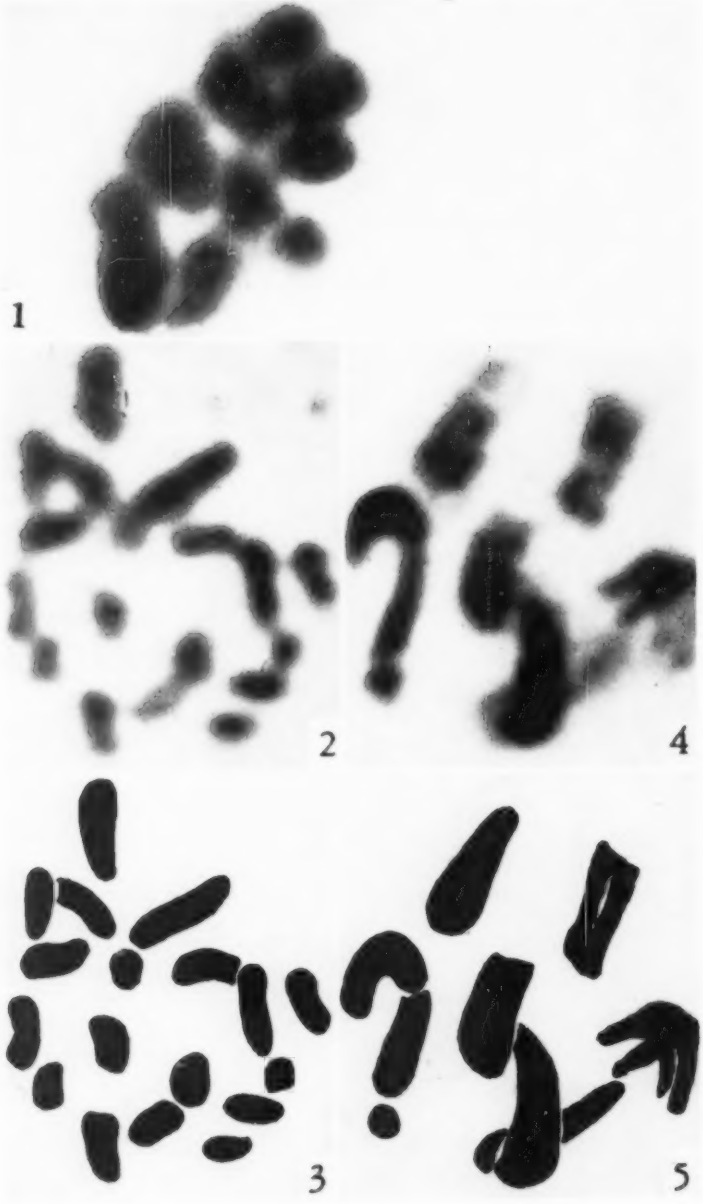
Since it is not common to find the leafy hepatics in a fertile state, the conventional method of determining the chromosome numbers from meiosis or the dividing spermatogenous cells in antheridia has not been followed. Instead aceto-orcein smears of the very young leaves at the meristematic apex of the plants have been made with excellent results. Whole plants were submerged for about four hours in 0.001 M-0.0005 M solutions of 8-hydroxyquinoline before squashing. The higher concentration was used for relatively more robust plants, such as species of *Madotheca* and *Plagiochila*, whereas for the delicate ones, as species of *Lophocolea* and *Chiloscyphus*, the lower concentration was employed. Intermediate concentrations of the chemical were used for plants of intermediate category, as species of *Frullania* and *Radula*. After this pre-treatment the terminal regions of the plants were excised and heated for a few minutes just short of boiling in a solution of aceto-orcein (9 parts) and normal hydrochloric acid (1 part). After about half an hour's fixation the meristematic apices were placed on a glass slide, and the smallest embryonic leaves teased out in a fresh drop of aceto-orcein. After adding a cover slip slight pressure was applied to flatten the cells and the preparation examined. The slide was made permanent in the usual manner by mounting in euparol. The photomicrographs were taken on Kodak P.25 plates.

Frullaniaceae

The family is represented in the Western Himalayas by the genus *Frullania*. Of the nine species reported from this area only two have been presently investigated. *F. retusa* Mitt. is sterile and has the chromosome number $n = 9$ (*Fig.* 1); one of the chromosomes is relatively smaller than the rest and represents an "m" chromosome. *F. squarrosa* Nees is fertile, the male plants show $n = 8$, and the female plants $n = 9$ chromosomes. The latter species has previously been worked out by Tatuno (1941) and Berrie (1958), and our results are in agreement with theirs. All the species of *Frullania* so far investigated by previous workers either show $n = 9$ chromosomes, or the males show $n = 8$ and the females $n = 9$.

Madothecaceae

Of the 21 species of *Madotheca* reported from the Western Himalayas four, namely *M. gollanii* St., *M. denticulata* Kash., *M.*


1
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macroloba St., and *M. appendiculata* St., were available for investigation. All of these show n = 8 chromosomes. In all these an "m" chromosome is present. Figure 6 shows the complement for *M. gollani*, and the "m" chromosome is at 9 o'clock. Reference to the literature shows that only nine species of the genus have so far been investigated, by Tatuno (1941; 1947, *vide* Delay, 1954) and Segawa (1955), and all these show the same number. In the

FIG. 6. *Madotheca gollani*, photomicrograph showing n = 8, with an "m" chromosome at 9 o'clock, × 8000.

FIG. 1. *Frullania retusa*, photomicrograph showing n = 9, with an "m" chromosome at 4 o'clock. FIG. 2. *Lophocolea bidentata*, photomicrograph showing n = 18. FIG. 3. *Lophocolea bidentata*, explanatory diagram of figure 2. FIG. 4. *Plagiochila accedens*, photomicrograph showing n = 9, with an "m" chromosome at 7 o'clock. FIG. 5. *Plagiochila accedens*, explanatory diagram of figure 4. (All figures, × 8000.)

complements drawn by Tatuno no "m" chromosome is mentioned, but it is very clear in the species investigated by the present authors (*Fig.* 6).

Radulaceae

Only one of the four species of *Radula* occurring in the Western Himalayas has been investigated. This species, *R. complanata* (L.) Dum., shows n = 12 chromosomes. The species was investigated also by Heitz (1942) from Europe; he reported n = ca. 16, but Tatuno (1935) found n = 6 for the same from Japan. Obviously the present taxon is a diploid on the base number 6. One more species, *R. kojana*, also worked out by Tatuno (1935), is reported to have n = 6 chromosomes. In some other species, such as *R. lindbergiana* and *R. valida*, the same author (1941) described the n number as 8. The base number 6 is rather exceptional in the Jungermanniales and is met with only in *R. complanata*.

Lophoziaceae

Eight genera are reported to occur in the Western Himalayas; one species in each of the three genera, *Chiloscyphus*, *Lophocolea*, and *Plagiochila*, have been studied. In *Chiloscyphus himalayensis* St. n = 9, *Lophocolea bidentata* (L.) Dum. n = 18 (*Fig.* 2 & 3), and *Plagiochila accedens* St. n = 9 (*Fig.* 4 & 5) have been observed. *Lophocolea bidentata* has also been studied by Heitz (1927), who found n = 9 chromosomes. Evidently the Himalayan taxon is diploid on the base number 9. All the species hitherto investigated of the other two genera mentioned above show n = 9 chromosomes. This involves two species of *Chiloscyphus*, *C. bescherellei* and *C. polyanthus* investigated by Tatuno (1951), and three of *Plagiochila*, namely *P. asplenioides* worked by Heitz (1927) and *P. japonica* and *P. ovalifolia* investigated by Segawa (1927).

The results of the present investigations are summarized, as follows:

Species	Gametic number	Investigator
Frullania squarrosa Nees	♂8, ♀9	Tatuno (1941) Berrie (1958), authors.
F. retusa Mitt.	9	Authors
Madotheca gollani St.	8	Authors
M. denticulata Kash.	8	Authors
M. macroloba St.	8	Authors
M. appendiculata St.	8	Authors

Radula complanata (L.) Dum.	12	Authors; n = ca. 16, Heitz (1927); n = 6, Tatuno (1951).
Chiloscyphus himalayensis St.	9	Authors
Lophocolea bidentata (L.)	18	Authors; n = 9, Heitz (1927).
Plagiochila accedens St.	9	Authors

Mehra (1957) earlier pointed out that two base numbers n = 9 and n = 8 are met with in the acrogynous Jungermanniales, and the former number is by far the commonest. The present position is that the number 9 is met with in 39 of the 44 genera investigated. In two genera, *Madotheca* and *Radula*, all the species show n = 8, while both 8 and 9 occur in *Frullania*. The base number n = 6 is found in *Radula complanata* (of which the diploid is encountered in the Himalayas); *R. kojana* is exceptional in the group and appears to have been derived from the number 8 which is met with in the other species of *Radula*.

Out of the 10 species presently investigated two are at the diploid level and the remaining eight at the haploid level.

We are thankful to our colleague Mr. R. S. Chopra, Reader in Botany, for help in identifying some of the specimens.

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MIELICHHOFERIA MIELICHHOFERIANA IN THE SOUTHERN APPALACHIANS

W. B. Schofield[1]

During the summer of 1958 I collected yellow-green cushions of an unknown bryaceous moss from sheltered crevices of Charlie's Bunion in the Great Smoky Mountains National Park, Tennessee. The collection attracted the attention of Dr. L. E. Anderson, who took it back to Duke University and found it to be *Mielichhoferia mielichhoferiana* (Funck) Limpr. I discovered later that W. C. Steere had collected the same species from Mt. LeConte during the 1947 American Bryological Society foray (rock crevices, Myrtle Point, Mt. LeConte, Sevier Co., Tenn., *W. C. Steere*, Sept. 5, 1947). In the autumn of 1958, Dr. A. J. Sharp collected this rare moss from The Jumpoff, also in the general region of Mt. LeConte, Great Smoky Mountains National Park (moist shaded phyllite, Jumpoff, Sevier Co., Tenn., *A. J. Sharp, R. A. Pursell & Dan Norris* 5837).

Several new localities of *Mielichhoferia mielichhoferiana* were discovered during the summer of 1959, and I was able to relocate it in all the previously known localities. The new collections, all from the Great Smoky Mountains National Park, Sevier County, Tennessee, are cited below:

Damp sheltered crevices, Charlie's Bunion (*W. B. & M. B. Schofield* 8560, 8826); exposed cliff crevices, same locality (*W. B. & M. B. Schofield* 9675); shaded cliff crevices, The Jumpoff (*W. B. Schofield* 10371); shaded cliff crevices below trail ridge, Boulevard Trail, about half way between Mt. Kephart and Myrtle Point (*W. B. Schofield* 10384); local on shelves of shaded area of cliff above Alum Cave overhang (*W. B. Schofield* 10470); on open cliff shelf at base of *Rhododendron carolinianum* and *Leiophyllum buxifolium* shrubs, Myrtle Point (*W. B. Schofield* 10481).

All of the aforementioned localities are in the general vicinity of Mt. LeConte, at altitudes above 5500 feet, and at each the moss occurs on slaty and argillaceous rock of the Anakeesta Formation (*cf.* King *et al.*, 1958). Attempts to locate *Mielichhoferia mielichhoferiana* from other rock formations in the Park area were unsuccessful. It is not a common moss and would appear to be highly local in distribution. Only at The Jumpoff and Charlie's Bunion is it abundant. In all the localities where *Mielichhoferia* was collected on the Anakeesta Formation, *Mercevа ligulata* (Spruce) Schimp. was present nearby. *Mercevа ligulata* was noted to be more widespread than *Mielichhoferia* on outcrops of the

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FIG. 1. North American distribution of *Mielichhoferia mielichhoferiana*.

Anakeesta Formation and is known at lower altitudes on other rock formations, especially in North Carolina (Anderson, 1958).

Both *Mercevа* and *Mielichhoferia* have been considered to be "copper mosses" (*cf.* especially Persson, 1956). Schatz (1955) suggested that "sulfur mosses" better describes them, noting that reduced sulfur possibly may be utilized by them in photosynthesis. Rocks of the Anakeesta Formation are "generally rich in carbon and sulfides; the latter produce rusty weathered surfaces" (King *et al.*, 1958). Iron pyrite is a common sulfide found in the slaty rocks of this formation. At Charlie's Bunion it may be noted, particularly where much has been weathered to produce rusty masses of limonite in many crevices. Both *Mercevа* and *Mielichhoferia* abound in these crevices, which suggests that the sulfur or iron may be important for the growth of these mosses. Sulfur appears to be the element constantly associated with the presence of these two moss genera wherever they are found in the world. Copper, on the other hand, is usually (but not constantly) present, as at sulfur springs, for example. Sulfur, therefore, seems to be a critical element restricting the distribution of these genera.

In most of the localities in the Smokies, *Mielichhoferia* is sterile. Only at The Jumpoff were abundant sporophytes found, and these were largely confined to small tufts in wet shaded crevices. Sporophytes were not observed in the large dense cushions on open cliff shelves and exposed crevices. *Merceya ligulata* has never been found fruiting in America.

Crum (1957) summarized the known distribution of *Mielichhoferia mielichhoferiana* in North America as follows: "in the Lake Superior region of Michigan and Ontario and also in Maine." He reported its presence in California as well and cited a specimen that I collected in California (*Schofield* 5748). Owing to an error, the habitat information on the label was given as a "tree trunk," it should read "slaty cliff above creek."

According to W. C. Steere (*in litt.*), this moss is known from northern Alaska and northern Ellesmere Island. Besides these widely separated collections, two specimens from New York State are in the Duke University Herbarium. These were sent to Grout by the collector, Fr. Hubert. Both specimens are from Cattaraugus County: "falls of the Connoisarauley Creek, October 1940" and "south branch of Cattaraugus Creek, about 3 miles SE of Forty Bridge, Gowanda, August 1940."

The known distribution of this species is, therefore, very local in mountains of California, northern Alaska, Maine, Tennessee and Ellesmere Island; also in Cattaraugus County, New York, and the Lake Ontario region of Michigan and Ontario. The accompanying map clearly emphasizes its disjunct distribution.

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DREPANOCLADUS TRICHOPHYLLUS FOUND IN NORTH AMERICA

HERMAN PERSSON[1] and HANSFORD T. SHACKLETTE[2]

In the summers of 1957 and 1958 the junior author, while employed as botanist for U. S. Geological Survey, made a collection of bryophytes numbering about 1418 packets from many locations throughout Alaska. These collections have been studied by the senior author, and the results will be published as soon as possible. Owing to special circumstances we have found it convenient to present one of the many interesting discoveries at this time—*Drepanocladus trichophyllus* (Warnst.) Mikut., which has not previously been reported from North America and was known only from the northern parts of Europe, especially Fennoscandia.

This species was described by Warnstorf in 1899 as *Hypnum trichophyllum* and was distributed by Mikutowicz in *Bryotheca Baltica* (no. 717, p. 216 in scheda, 1913) as *Drepanocladus trichophyllus* (Warnst.) Mikut., but had become an almost forgotten species until Tuomikoski called attention to it in 1949 in his outstanding study of the *Drepanocladus exannulatus* group. He considered it to be a valid species, and it is of particular interest in being one of the very few mosses which is a genuine submerged species, always growing on the bottom of lakes and pools. It is apparently a species of low nutrient requirements, and its habitat is often of an oligotrophic nature.

The senior author has studied *Drepanocladus trichophyllus* from at least 50 Scandinavian localities (Persson, 1942a, 1944) and agrees with Tuomikoski that it must be considered a good species. Of the three other species in the *exannulatus* group [*D. procerus* (Ren. & Arn.) Warnst., *D. tundrae* (Arn.) Loeske, and *D. exannulatus* (BSG) Warnst. *s. str.*] it is most closely related to *D. exannulatus*. It differs principally in having leaves ending in a long, fine acumination and in having the nerve (especially in branch leaves) long-excurrent. The stems and branch tips have long, parallel leaves which give them a characteristic brush-shaped appearance. The aspect of this moss is therefore very distinctive, and the species may be recognized at once in the field by one with a little experience.

In regard to the distribution of this species, Tuomikoski (1949, p. 37) may be cited (in translation): "The distribution of *Drepano-*

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cladus trichophyllus must be considered to be very poorly known. In Finland and Sweden (see Persson 1942, p. 322) the species is not rare, especially in the northern parts. It is probably also found in Latvia . . . and may be in Prussia. Its distribution will probably prove to be about the same as that of *Calliergon megalophyllum* Mikut. (Tuomikoski 1940b; Persson 1942)." Tuomikoski presented a map showing its distribution in Fennoscandia, in which a few localities are given in Norway, many in Sweden and Finland, and also some in the adjacent parts of Russia. With the exception of the uncertain reports of its occurrence in Latvia and Prussia, only a single locality was known at that time outside Fennoscandia and the Russian localities close to the boundary; this locality was Archangelsk, which is close to the Fennoscandian region.

The discovery by the junior author shows that Tuomikoski was quite correct in predicting the distribution pattern of *Drepanocladus trichophyllus* to be similar to that of *Calliergon megalophyllum*, since he realized that the bryophyte vegetation of lakes has been studied very little outside of Fennoscandia. *Calliergon megalophyllum* was described by the Latvian bryologist Mikutowicz in 1908 but, similarly to *Drepanocladus trichophyllus*, had been almost forgotten until again Tuomikoski in 1940 called attention to it and proved it to be a good, distinct species. It belongs to the same very restricted ecological group as *Drepanocladus trichophyllus*, and these two species are very often found growing together, as was true in the Alaskan locality. The distribution of *Calliergon megalophyllum* is given as Fennoscandia, middle and northern Russia and Siberia. It was therefore not surprising when the senior author (1942, 1946, 1947) reported it from Alaska and the Yukon Territory as new to North America. Two of the three localities referred to small fragments of this species obtained by a search for bryophytes on rootstocks, stems and other parts of pressed vascular plants, which in these cases were *Calla palustris* L. and *Ranunculus purshii* Richards.

In the summer of 1958 *Drepanocladus trichophyllus* was collected by the junior author in the Lower Yukon River district of Alaska (see Hultén 1941, p. 4). The locality is given on the label as "Aquatic, in bog lake at mouth of Barometer Creek. Red Devil Mine, on the middle Kuskokwim River. Elevation approx. 330 feet. July 2, 1958. Hansford T. Shacklette, 5136." (The elevation has since been determined to be approximately 230 ft.) It was growing in company with *Calliergon megalophyllum* and an undeveloped *Bryum* (probably *B. ovatum* Jur.). This small unnamed lake is located on an alluvial terrace of the Kuskokwim River. It receives a continuous water supply from Barometer Creek,

a small creek less than a mile in length, that heads on a low ridge behind McCally and Fuller Creeks and flows in a narrow channel cut into the vegetation mat and silt blanketing the valley floors. The bedrock types in this area are graywacke and shale, forming an interbedded unit of Cretaceous age (Cady, Wallace, Hoare, & Webber, 1955). This sequence is intruded by sills, sheets, and dikes of biotite basalt and albite rhyolite of Tertiary age. A cinnabar deposit is associated with altered biotite basalt on the east side of Barometer Creek. The bedrock is commonly covered with a loess deposit as much as 25 feet in thickness. A subarctic climate characterizes this region—short and rather wet summers and long, dry, and cold winters. Temperature averages near 50° F. in summer and 0° F. in winter, with a maximum of 90° F. and a minimum of −58° F. having been recorded. Permafrost is sporadically distributed in the Barometer Creek area. The lake is bordered with a zone of dense vegetation which is rooted near the shore but free-floating toward the open water in the center of the lake. Characteristic vascular plants of this lake include *Utricularia macrorhiza* LeConte, *Callitriche verna* L., *Eleocharis acicularis* (L.) R. & S., *Juncus alpinus* ssp. *nodulosus* (Wahl.) Lindm., *J. arcticus* ssp. *alaskanus* Hult., *Cicuta mackenzieana* Raup, *Potentilla palustris* (L.) Scop., *Calla palustris* L., *Equisetum limosum* L., *Carex aquatilis* Wahl., and *C. rostrata* Stokes. It should also be mentioned that *Drepanocladus tundrae* and *D. uncinatus* were growing in the shallow water in the edge of this lake.

About a year preceding the discovery of *Drepanocladus trichophyllus* in Alaska as a new North American record, another species of the *exannulatus* group studied by Tuomikoski (*D. procerus*) also appeared as new to North America. This moss was found in a bryophyte collection made by Dr. H. Sjörs of Stockholm during his field studies in northern Ontario, Canada, in 1957. This species was previously known only from Fennoscandia, where more than 100 localities were shown on a distribution map by Tuomikoski. A paper will soon be published by Sjörs and the senior author about this Ontario collection.

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LICHEN SUCCESSION IN ABANDONED FIELDS IN THE PIEDMONT OF NORTH CAROLINA

Harold Robinson[1,2]

Previous studies of plant succession in abandoned fields in the Piedmont of North Carolina have dealt with vascular plants (Oosting, 1942) and bryophytes (Bliss & Linn, 1955). The present study is intended to summarize the associated lichen succession. Studies of lichens in abandoned fields include those of Bard (1952) in the Piedmont of New Jersey, and Evans and Dahl (1955) in southeastern Michigan. Only the former deals with succession. Recently the effects of raking and burning on the terrestrial lichen vegetation in 60-year-old pine stands has been studied in North Carolina (Johnsen, 1959).

The present study is of 12 fields near Durham, Durham Co., North Carolina. Following the methods of Bliss and Linn, a square 100 ft. × 100 ft. was set up in each field. At each corner of the square a plot 6 ft. × 2 ft. was sampled.

Specimens were identified by use of a manuscript key to the local *Cladoniae*, *sensu* Evans, by Dr. W. L. Culberson. While identifications were based largely on morphological characters, the identification of most sterile, early-stage colonizers was possible only by the application of chemical techniques (Asahina, 1936-40; Evans, 1943; Hale, 1957). For thallus spot tests the usual lichen-

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[2] The author wishes to thank Dr. W. L. Culberson, who suggested the problem, for his aid during the study and the preparation of the manuscript.

ological reagents, calcium hypochlorite (C), paraphenylenediamine (P) or potassium hydroxide (K) were used. Positive results are signified by "+" with a note of the color produced; negative results are shown by "—."

In addition microchemical techniques were used, involving the extraction of the lichen substances and microscopic identification of the crystals they produced. Extractions were made on warmed slides by washing lichen fragments with drops of solvent (usually acetone, rarely chloroform). In some cases the appearance of the dried residue under the microscope was sufficiently distinctive for identifications, but usually a reagent was used to recrystallize the substance or to form a crystalline salt with it. If necessary the residue may be scraped together before applying the reagent. The two solutions used in the study were (a) 1 part glycerine, 3 parts glacial acetic acid (G. E. solution) and (b) 2 parts glycerine, 2 parts alcohol and 1 part *o*-toluidine (G. A. *o*-T solution).

Since norstictic acid in the presence of stictic acid is difficult to demonstrate by the G. A. *o*-T solution, an aqueous solution of potassium carbonate may be used. The formation of needle-shaped, reddish crystals indicates the presence of norstictic acid.

When usnic acid was suspected in a sample, but its low concentration or the presence of other substances precluded its recrystallization, the chloramine-T (CAT) test was used (Asahina, 1952). A few drops of 5% alcoholic solution of CAT were added to a benzene extract of the lichen. A distinct yellow color of the solution constitutes a positive test.

The following key includes the 11 species of *Cladonia* encountered in the study.

1. Plants without noticeable squamules; podetiate or crustose 2
   2. Plants podetiate; surface covered with loose hyphae ..... *C. subtenuis* (des Abb.) Evans
   2. Plants with a primary crust; podetial surface smooth ..... *C. papillaria* (Ehrh.) Hoffm.
1. Plants squamulose 3
   3. Podetia goblet-formed; dried acetone extract with colorless, slender, pointed, somewhat branched crystals (grayanic acid) ..... *C. grayi* Merr.
   3. Podetia not goblet-formed; acetone extract otherwise 4
      4. P+ red 5
         5. Squamules unlobed or with only a few large lobes (lobes 1 mm. broad or more) ..... *C. mateocyatha* Robb.
         5. Squamules with numerous small lobes (lobes usually less than 0.5 mm. broad) 6
            6. Squamules sorediate ..... *C. delicata* (Ehrh.) Fr.
            6. Squamules esorediate ..... *C. capitata* (Mx.) Spreng.
      4. P+ yellow or P— 7
         7. At least the undersurface of the squamules C+ blue-green ..... *C. strepsilis* (Ach.) Vain.

7. Undersurface C— 8
8. Squamules with numerous small lobes (lobes usually less than 0.5 mm. broad); P— 9
9. Apothecia brownish, chloroform extract treated with G.E. solution producing only yellowish, needle-like or irregular crystals (usnic acid) ..... *C. piedmontensis* Merr.
9. Apothecia red, extract treated with G.E. solution producing crystal types including colorless cubes and prisms (barbatic acid) ..... *C. cristatella* (Flk.) Schaer.
8. Squamules unlobed or with large lobes (lobes 1 mm. or more broad); usually P+ yellow 10
10. Acetone extract treated with G.A.*o*-T solution producing usually curved, needle-like crystals (atronorin) with either colorless, hexagonal plates (stictic acid) or yellow quadrate plates (norstictic acid) ..... *C. polycarpia* Merr.
10. Norstictic acid present, atronorin and stictic acid absent ..... *C. subcariosa* Nyl.

No other genus of lichens was encountered in the fields studied.

A summary of the lichen succession with frequency values from the fields studied is given in figure 1. The lichen vegetation in relation to the vascular plant and bryophyte succession is divided into the following seven periods:

I. The rapid changes in the vascular succession during the first two years include the following three stages; the newly abandoned fields which rapidly become dominated by *Digitaria sanguinalis* (crabgrass), the one-year fields in which *Conyza canadensis* (horseweed) is dominant and fields in the second year after abandonment in which *Aster pilosus* (white aster) is dominant. The three stages together contain the greatest quantity and variety of bryophytes (Bliss & Linn, 1955). The only lichen collected was associated with foreign debris, a specimen of *Cladonia capitata* in the second-year field, growing on a fragment on an oak leaf.

II. From the third to about the tenth year *Andropogon virginicus* is dominant in the fields with pine becoming more prominent and even exceeding six feet in height in the later stages. While the *Andropogon* furnishes a denser cover than the preceding dominants, the dense mat of vegetation near the ground decays and is incorporated into the soil. The bryophyte flora, while generally diminished, contains increased amounts of *Ditrichum pallidum*. Many lichen species in early stages of development grow on the organic debris or on the base of the *Andropogon*. Only one cluster of squamules (*Cladonia capitata*) of many examined could not definitely be demonstrated to grow on organic substrate. The most common species was *Cladonia capitata*, but only *C. cristatella* had apothecia. Less common and only slightly developed were *C. subcariosa*, *C. subtenuis*, *C. grayi*, *C. piedmontensis* and *C. papillaria*.

III. In the 12- to 15-year fields the young pines form dense and relatively closed stands with trees 12 to 20 feet tall. The characteristic bryophytes, *Ditrichum pallidum*, *Atrichum angustatum*, and *Rhynchostegium serrulatum*, show a high constance (Bliss & Linn, 1955). During this stage is the early portion of a peak in lichen development. *Cladonia strepsilis* appears, and *C. subcariosa*, *C. polycarpia*, *C. subtenuis*, *C. grayi*, *C. piedmontensis*, *C. capitata* and *C. cristatella* had well-developed podetia.

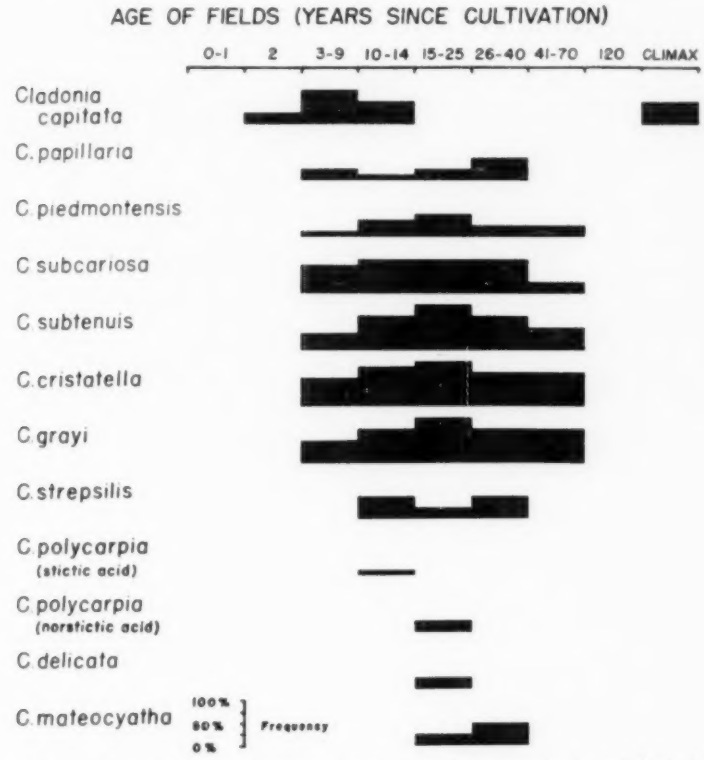

FIG. 1. Graph showing frequency values for lichen species in old-fields in the Piedmont of North Carolina.

IV. Natural thinning of the pines occurs in the 15- to 40-year stage, but pine continues to dominate completely. *Ditrichum*, *Atrichum*, and *Rhynchostegium* progressively diminish as *Leucobryum albidum*, *Dicranum scoparium*, and *Isopterygium micans* appear. In this stage the greatest variety and peak of development of Cladonias occur. Only *C. capitata* of the species encountered in the study was absent. *C. papillaria* had well-developed podetia, absent in earlier stages, and some *C. grayi* had apothecia.

V. In the 40- to 70-year fields the pines remain dominant but with a well-developed understory of deciduous trees. The bryophytes continue as in the latter part of the previous period. A definite decline in the lichen vegetation was noticed with one quadrat having a heavy litter of deciduous leaves and no lichens. Only *C. cristatella*, *C. grayi*, *C. subtenuis*, *C. subcariosa* and *C. piedmontensis* were found.

VI. An approximately 120-year old field had old pines and large deciduous trees. The ground was covered with deciduous leaves and no bryophytes or lichens were present.

VII. An area of climax forest was dominated by oak and hickory with an understory of deciduous trees and shrubs. A number of bare patches of ground supported a few bryophytes and the single lichen *Cladonia capitata*.

A distinct succession is shown by the lichen vegetation with a peak of variety and development during the younger pine stages. On the basis of this succession three types of lichens can be distinguished.

The largest group of species, present in a wide range of successional stages, includes *C. cristatella*, *C. subcariosa*, *C. grayi*, *C. subtenuis*, and *C. piedmontensis*. The first two of these species are also present in a wide range of successional stages in the Piedmont of New Jersey (Bard, 1952).

The second group, characteristic of the peak period between 10 and 40 years, includes *C. mateocyatha* and *C. strepsilis*. *C. polycarpia*, restricted to these stages, was represented by only two specimens which were of different chemical strains. It is probably best considered as ecologically not different from the morphologically very similar *C. subcariosa*. Also *C. delicata*, while found on the ground only in a field in this 10–40-year stage, is common on the bases of older pines and as such is potentially a soil colonizer during any of the later pine stages.

The most divergent pattern is shown by *C. capitata*. This species was the most important if not the first of original colonizers, and it was the only species observed in the climax forest, but it was absent from the older pine stages and the period in which the lichen vegetation was in its peak. Possibly the accumulation of a litter of pine needles is detrimental to its development.

The present study and the one by Bard (1952) in New Jersey find no lichens during the first few years. The delay in lichen colonization is longer than the time necessary for the development of the lichens to an observable stage. The absence of the lichens might be the result of competition with the dense mat of herbs and bryophytes but the evidence suggests another reason.

As the low mat of herbs and bryophytes dies and decays, the lichens become abundant. Rather than colonize the bare soil the clusters of squamules appear on the organic debris of the previous vegetation and on the bases of the *Andropogon*. In addition, the foreign leaf fragments appeared to accelerate lichen colonization in the second-year field. The absence of a substrate of organic debris may be the factor limiting lichen development in the early stages.

In contrast, during later stages the increased litter from deciduous leaves, as indicated by Bliss and Linn (1955) and Johnsen

(1959) seems to be the primary factor in eliminating cryptogamic vegetation. Even in the climax forest only relatively bare portions of the forest floor contained lichens.

Summary

Observations were made on the lichen vegetation associated with 12 old fields of various ages in Durham County, North Carolina. Three groups of lichens are distinguished by their occurrence in various successional stages. *Cladonia capitata* has been observed only in the early stages and in the climax forest, *C. strepsilis* and *C. mateocyatha* inhabit only fields between 10 and 40 years old, *C. cristatella*, *C. grayi*, *C. subtenuis*, *C. subcariosa*, and *C. piedmontensis* appear in fields ranging from those dominated by *Andropogon* (abandoned three years) to those with older pine woods after which they are eliminated by the heavy deciduous leaf litter. During the first few years after abandonment lichens are absent from the fields. The limiting factor appears to be the lack of a substrate of organic debris.

The variation in the nature of the organic debris during the succession is the major factor controlling the composition of the lichen vegetation.

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A PRELIMINARY CHECKLIST OF MOSSES OF ITASCA STATE PARK, MINNESOTA

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During the First Summer Session, 1957, of the Forestry and Biological Station of the University of Minnesota on Lake Itasca

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in Itasca State Park, the author was a participant in the Institute for High School Biology Teachers supported by the Louis W. and Maud Hill Family Foundation. As a project for the institute the author started a small moss collection. In 1958 another opportunity was provided by the Hill Family Foundation to return to the station, and half of the time during the First Summer Session was devoted again to the collection of mosses. In 1959 through the Biological Research and Training Program sponsored by the National Science Foundation, the author was again permitted to return to the station, this time for two sessions, to continue the work with mosses. This checklist is a part of the fruit of that work.

The general plan of the work was to select certain areas and to attempt to collect *all* the mosses in each area. It was thought that in so doing mosses which ordinarily do not fruit in this region would be collected as well as those that do. Fourteen such areas were selected and are marked on the map accompanying the collection which has been deposited in the moss herbarium of the Forestry and Biological Station.

Special mention should be made of Schoolcraft Island in Lake Itasca. (This is marked No. 10 on the collection map.) This island is close to the station and has been the subject of rather intensive study in other biological fields through the years. It has been staked out carefully in quadrats 50 feet square. For this study an attempt was made to collect all of the mosses in each quadrat even if some of the same species had already been collected in other quadrats. This method was successful because mosses were collected which otherwise might have been missed. It was the most fruitful single collecting area as far as number of species found is concerned.

At the moment of writing it is found that there are 110 species of mosses from 53 genera and 21 families in Itasca State Park. The author collected all but 20 of these species. Several more species are likely to be found after further collecting. This is only a preliminary list.

The author wishes to express his gratitude to those who aided in this study—to Dr. William H. Marshall, Associate Director of the station; Dr. Thorvald Schantz-Hansen, Director; Dr. Janet Stein, who advised the author during the project; Dr. Paul Ralston, who helped get it started; Dr. R. V. Drexler, who gave the author his first lesson on *Sphagnum* on a hot afternoon; and Dr. R. I. Evans, who contributed much to the moss herbarium at the station and taught the course in bryophytes at the University of Wisconsin. E. F. Haskins, R. L. Meyer, D. Davidson and others have contributed specimens and aided in identification.

Sphagnum capillaceum (Weiss) Schrank.
Sphagnum magellanicum Brid.
Sphagnum recurvum P. Beauv.
Sphagnum squarrosum Crome
Sphagnum subsecundum Nees
Sphagnum teres (Schimp.) Angstr.
Sphagnum warnstorfianum DuRietz
Sphagnum wulfianum Girg.
Tetraphis pellucida Hedw.
Atrichum undulatum (Hedw.) P. Beauv.
Polytrichum commune Hedw.
Polytrichum gracile Sm.
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Fissidens adiantoides Hedw.
Fissidens osmundioides Hedw.
Ceratodon purpureus (Hedw.) Brid.
Dicranella heteromalla (Hedw.) Schimp.
Dicranella squarrosa (Schrad.) Schimp.
Dicranoweisia crispula (Hedw.) Lindb.
Dicranum drummondii C. M.
Dicranum flagellare Hedw.
Dicranum rugosum Brid.
Dicranum scoparium Hedw.
Leucobryum glaucum (Hedw.) Schimp.
Barbula eustegia Card. & Thér.
Didymodon recurvirostris (Hedw.) Jenn.
Tortula mucronifolia Schwaegr.
Weisia controversa Hedw.
Hedwigia ciliata (Hedw.) P. Beauv. f. *secunda* (BSG) Jones
Funaria hygrometrica Hedw.
Orthotrichum elegans Hook. & Grev.
Orthotrichum obtusifolium Brid.
Orthotrichum pumilum Dicks.
Timmia megapolitana Hedw.
Aulacomnium palustre (Web. & Mohr) Schwaegr.
Philonotis muhlenbergii (Schwaegr.) Brid.
Amblyodon dealbatus P. Beauv.
Bryum angustirete Kindb.
Byrum argenteum Hedw.
Bryum caespiticium Hedw.
Bryum cuspidatum (Br. & Sch.) Schimp.
Bryum inclinatum (Web. & Mohr) Sturm
Bryum pallens (Web. & Mohr) Röhl.
Bryum pseudotriquetrum (Hedw.) Schwaegr.
Bryum uliginosum (Brid.) BSG
Leptobryum pyriforme (Hedw.) Schimp.
Pohlia elongata Hedw.
Pohlia filiformis (Dicks.) Andrews
Pohlia nutans (Hedw.) Lindb.
Pohlia wahlenbergii (Web. & Mohr) Andrews
Rhodobryum roseum (BSG) Limpr.
Mnium affine Bland.
Mnium cuspidatum Hedw.
Mnium medium BSG
Mnium punctatum Hedw.
Mnium longirostrum Brid.
Mnium serratum Brid.
Mnium spinulosum Br. & Sch.
Amblystegiella confervoides (Brid.) Loeske
Amblystegium compactum (C. M.) Aust.
Amblystegium juratzkanum Schimp.
Amblystegium serpens (Hedw.) Br. & Sch.
Amblystegium varium (Hedw.) Lindb.
Brachythecium acutum (Mitt.) Sull.
Brachythecium oxycladon (Brid.) Jaeg. & Sauerb.
Brachythecium pseudocollinum Kindb.
Brachythecium rutabulum (Hedw.) BSG
Brachythecium salebrosum (Web. & Mohr) BSG
Brachythecium velutinum Br. & Sch.
Brotherella recurvans (Mx.) Fl.
Calliergonella schreberi (BSG) Grout
Camptothecium nitens (Hedw.) Schimp.
Campylium chrysophyllum (Brid.) Bryhn
Campylium hispidulum (Brid.) Mitt.
Climacium dendroides Web. & Mohr
Drepanocladus aduncus (Hedw.) Warnst.

Drepanocladus aduncus var. *kneiffii* fo. *intermedius* (Br. & Sch.) Mönk.
var. *polycarpus* (Bland.) Warnst.
Drepanocladus uncinatus (Hedw.) Warnst.
Drepanocladus vernicosus (Lindb.) Warnst.
Entodon cladorrhizans (Hedw.) C. M.
Eurhynchium pulchellum (Hedw.) Jenn.
Heterophyllium haldanianum (Grev.) Kindb.
Hygroamblystegium irriguum (Wils.) Loeske
Hylocomium splendens (Hedw.) BSG
Hypnum crista-castrensis Hedw.
Hypnum imponens Hedw.
Hypnum lindbergii Mitt.
var. *elatum* (Schimp.) Ketchl.
Hypnum pratense Koch
Hypnum reptile Mx.
Leptodictyum riparium (Hedw.) Warnst.
fo. *flaccidum* (Lesq. & James) Warnst.
Leptodictyum trichopodium var. *Kochii* (Br. & Sch.) Broth.
Plagiothecium denticulatum (Hedw.) BSG
Plagiothecium deplanatum (Sull.) Grout
Plagiothecium pulchellum (Hedw.) Grout
Plagiothecium turfaceum (Lindb.) Lindb.
Platygyrium repens BSG
Pylaisia jamesii Sull. & Lesq.
Pylaisia polyantha (Hedw.) BSG
Pylaisia selwynii Kindb.
Pylaisia subdenticulata Schimp.
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Anomodon minor (P. Beauv.) Lindb.
Helodium blandowii (Web. & Mohr) Warnst.
Leskea polycarpa Hedw.
Thuidium delicatulum (Hedw.) Mitt.
Thuidium microphyllum (Hedw.) Best
Thuidium philibertii Limpr.
Thuidium recognitum (Hedw.) Lindb.
Neckera pennata Hedw.
Leucodon sciuroides (Hedw.) Schwaegr.

ADDITIONS TO THE MOSS FLORA OF MASSACHUSETTS[1]

FRANK J. HILFERTY[2]

In working on the moss flora of Massachusetts (a preliminary report was given by the author at the Ninth International Botanical Congress), the 28 taxa treated in this article were noted as apparently not having been reported from Massachusetts. Of the 23 species and five varieties considered here, range extensions of

[1] Grateful acknowledgment is made to the National Science Foundation for a Faculty Science Fellowship and to Harvard University for an appointment as a Research Fellow. These appointments have made this publication possible.

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significance are reported for *Fissidens bushii*, *Grimmia doniana*, *Hypnum vaucheri*, and *Pseudisothecium myosuroides*.

The taxonomic treatment of the Sphagnaceae is that of Andrews in the *North American Flora*. All other families, for the most part, follow the taxonomy of Grout's *Moss Flora of North America North of Mexico*. If a specific name differs from that in the latter work, the binomial as in Grout is given in parentheses.

Following each species and variety are the counties from which specimens have been seen and examined. After each county, herbarium symbols indicate herbaria where at least one specimen of each taxon from a given county has been deposited. A key to the symbols follows: CUW—Clark Univ. Herbarium, Biology Dept., Clark Univ., Worcester, Mass. EMD—Herbarium of Elizabeth M. Dunham, Birch Road, Wellesley, Mass. FH—Farlow Herbarium, Harvard Univ., Divinity Ave., Cambridge, Mass. FJH—Herbarium of Frank J. Hilferty, Dept. of Biological Sciences, State Teachers College, Bridgewater, Mass. MASS—Dept. of Botany, Clark Hall, Univ. of Massachusetts, Amherst, Mass. NEBC—Herbarium of the New England Botanical Club, Inc., c/o The Gray Herbarium, Harvard Univ., Divinity Ave., Cambridge, Mass. PM—Peabody Museum, Essex St., Salem, Mass. WELC—Herbarium of the Dept. of Botany, Wellesley College, Wellesley, Mass.

Sphagnum imbricatum v. *affine* (Ren. & Card.) Warnst. Barnstable (NEBC); Essex (FH, NEBC, PM); Middlesex (EMD, FH, NEBC); Norfolk (NEBC); Suffolk (NEBC); Worcester (EMD, FH).

Sphagnum macrophyllum Bernh. Barnstable (NEBC); Plymouth (NEBC).

Sphagnum plumulosum Röll. Barnstable (NEBC); Essex (NEBC, PM); Worcester (NEBC).

Sphagnum plumulosum v. *flavicomans* (Card.) Andrews. Barnstable (FH); Norfolk (FH, NEBC).

Sphagnum tenellum Pers. Essex (FH, NEBC, PM); Middlesex (FH, NEBC); Norfolk (FH, NEBC); Suffolk (FH, NEBC).

Sphagnum teres (Schimp.) Angstr. Essex (PM); Hampden (NEBC). Middlesex (EMD, FH); Norfolk (FH, NEBC); Worcester (FH).

Fissidens bushii Card. & Thér. Bristol (NEBC).

Fissidens viridulus (Web. & Mohr) Wahl. Middlesex (FH, WELC); Norfolk (WELC).

Dicranella cerviculata (Hedw.) Schimp. Worcester (NEBC, WELC).

Dicranella schreberiana (Hedw.) Schimp. (*Dicranella schreberi*). Berkshire (NEBC).

Dicranum muhlenbeckii BSG. Berkshire (FJH).

Encalypta streptocarpa Hedw. Hampshire (MASS); Worcester (CUW, EMD).

Tortella tortuosa (Hedw.) Limpr. Berkshire (EMD); Essex (FH, NEBC); Franklin (MASS); Hampshire (MASS).

Grimmia doniana Sm. Hampshire (MASS).

Ephemerum spinulosum Schimp. Bristol (NEBC); Essex (PM); Middlesex (EMD, FH).

Bryum argenteum v. *lanatum* (Palis.) BSG. Norfolk (FH).

Pohlia pulchella (Hedw.) Lindb. Hampshire (FH); Middlesex (FH, NEBC); Norfolk (EMD, FH, NEBC); Suffolk (NEBC).

Pseudisothecium myosuroides (Hedw.) Grout. Essex (FH, FJH, NEBC).

Haplocladium virginianum (Hedw.) Broth. (*Thuidium virginianum.*) Bristol (NEBC); Middlesex (EMD, WELC); Norfolk (WELC); Suffolk (NEBC); Worcester (FH).

Campylium polygamum (BSG) Bryhn. Barnstable (FJH, NEBC); Middlesex (EMD, FH).

Hygroamblystegium fluviatile (Hedw.) Loeske. Essex (FH, NEBC, PM); Middlesex (FH, NEBC); Norfolk (WELC); Plymouth (EMD); Suffolk (NEBC).

Hygrohypnum luridum (Hedw.) Jenn. (*Hygrohypnum palustre.*) Norfolk (FH).

Leptodictyum trichopodium v. *kochii* (BSG) Broth. Essex (FH, NEBC); Middlesex (FH, NEBC, WELC); Worcester (EMD).

Plagiothecium roeseanum (Hampe) BSG. Essex (NEBC, WELC); Franklin (EMD); Hampshire (EMD).

Brotherella delicatula (James) Fl. Berkshire (NEBC).

Hypnum cupressiforme v. *subjulaceum* Mol. Bristol (NEBC, WELC); Middlesex (FH).

Hypnum fertile Sendt. Berkshire (CUW); Bristol (EMD); Middlesex (WELC); Suffolk (NEBC).

Hypnum vaucheri Lesq. Essex (NEBC).

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MARGARET FULFORD[1]

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NEWS AND NOTES

Dr. Alexander W. Evans, renowned hepaticologist and lichenologist and honorary member of the American Bryological Society, died on December 6, in a New Haven hospital, at the age of 91.

The first volume of the *Index Muscorum* (A-C, 548 pp.) is now available from the International Bureau for Plant Taxonomy, Lange Nieuwstraat 106, Utrecht, Netherlands—free to regular institute members of IAPT, $8.00 to associate institute and regular personal members, and $15.00 to others.

The Index to volumes 1-60 of *The Bryologist* is now available at a cost of $5.00. It is an index to authors and subjects as well as genera and species and consists of 217 pages. Orders should be sent to Dr. Lewis E. Anderson, Dept. of Botany, Duke University, Durham, N. C.

The annual business meeting and field excursion of the British Bryological Society will be held April 6-13 at Oswestry, Shropshire. Dr. E. F. Warburg will lead the excursion. Information is available from the local secretary, Mr. A. J. E. Smith, Dept. of Botany, South Parks Rd., Oxford.

Dr. Walter B. Kiener, 64, formerly biologist for the Nebraska State Game Forestation and Parks Commission, died on August 24, 1959, at Lincoln, Nebraska.

The University of Colorado has purchased the herbarium of the French lichenologist, Abbé F. Hy. The herbarium includes Ripart's very large algae herbarium in addition to Hy's lichen collection as well as Rabenhorst's *Lichenes Europaei* and Mougeot, Nestler, and Schimper's *Stirpes Crypt. Voges-Rhenanae.*

Sam Shushan and William Weber, of the University of Colorado, have received an NSF grant of $25,000 for a 3-year study of the taxonomy and phytogeography of the lichens of western North America.

Many years before its official opening in 1900, The New York Botanical Garden began to build up an outstanding bryological herbarium, thanks to the active research interests of Mrs. Elizabeth G. Britton, wife of the Garden's first Director, and of Robert S. Williams. The extensive collections made in many parts of the world by Williams and by other staff members, the arrangements for exchange of duplicates and of type material made by Mrs. Britton, and the purchase of several excellent herbaria abroad, especially those of August Jaeger and William Mitten, added greatly to the wealth of the bryological collections. With the death of Mrs. Britton in 1934 and of Williams in 1945, the rate of acquisition of bryological material by the Garden slackened and bryological research was carried on only by occasional visitors. Now, however, the bryological interests of The New York Botanical Garden have been revivified, and the collections are again being curated actively. As a consequence of the Garden's renewed desire to augment its bryological collections, bryologists all over the world who have material of unusual interest are invited to enter into exchanges with The New York Botanical Garden. All bryologists who describe new species are requested to deposit a part of their type material in the Elizabeth Gertrude Britton Herbarium of The New York Botanical Garden, where it will be easily accessible in an important bryological center.

At the annual ABS business meeting the following were elected officers for 1960: Pres. Roy F. Cain; Vice-Pres. Betty Higinbotham; Sec.-Treas. Wm. A. Weber. Harry Williams was appointed director of the Hepatic Exchange to replace L. F. Koch, who resigned.

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Volume 62, Number 3 (pp. 165-213) was issued Feb. 9, 1960

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THE MOSS EXCHANGE

As announced in THE BRYOLOGIST **38**: 100, Sept.-Oct., 1935, there is now an exchange for mosses. This exchange is available to members of the American Bryological Society upon payment of annual dues of 25c to DR. E. H. KETCHLEDGE, Dept of Forest Botany, State College of Forestry, Syracuse 10, New York. Only fully identified specimens in packets with complete data on them should be sent in. It is suggested that there be five or more packets of each species.

These two exchanges offer an excellent opportunity for A.B.S. members to build up their own herbaria of choice, well-labelled specimens.